DENTAL LIBRARY
JUN 4 1935
e.4

Volume XIV Number 6

JOURNAL of DENTAL RESEARCH

Official Publication of the
INTERNATIONAL ASSOCIATION FOR DENTAL RESEARCH

December, 1934

Human saliva. II. A technical procedure for calcium analysis. *W. W. Wainright*, D.D.S., M.S. (University of California)..... 425
Studies on the chemistry of mixed human saliva. I. Attempts to correlate chemical composition of mixed human saliva with rate of secretion. *J. B. Brown*, Ph.D., and *N. J. Klotz*, B.S. (Ohio State University).... 435
Relation of dental caries to disease, menstrual experience, and physical measurements of young women. *Ruby L. Cunningham*, M.D. (University of California)..... 439
Biochemical studies of aqueous extracts of enamel and dentin in relation to dental caries. *Maxwell Karshan*, Ph.D., *Richard Weiner*, B.S., D.D.S., and *Nathan Stofsky*, B.S., D.D.S. (Columbia University)..... 445
Solution rate of apatite in an average mouth. *Peter J. Brekhus*, B.A., D.D.S., F.A.C.D., and *W. D. Armstrong*, Ph.D. (University of Minnesota).... 455
A non-torque clasp. *Arthur B. Gabel*, M.A., D.D.S. (University of Pennsylvania)..... 457
Effects of short electric waves upon streptococci from infected teeth. *J. S. Oartel*, D.D.S., M.S., and *E. Alfred Wolf*, Ph.D. (University of Pittsburgh)..... 459
Supplement:
I. International Association for Dental Research. List of membership as of December 1, 1934. Compiled by the *General Secretary*. 471
II. Note on the William J. Gies Fellowship in Biological Chemistry at Columbia University. *Edgar G. Miller, Jr.*, Ph.D., Chairman of the Fellowship Committee..... 474
III. Quotations: dental journalism..... 475
IV. Correction: *Frances Krasnow*, M.A., Ph.D..... 480
Index..... 481
General matter for Volume XIV:
Title page of the February issue..... i
Title page of the issues for April–December, inclusive..... ii
Future of the *Journal of Dental Research*..... iii
Contents of the Volume..... v

PROPERTY OF DENTAL LIBRARY UNIVERSITY OF MICHIGAN DON'T MUTILATE OR REMOVE

PUBLISHED BI-MONTHLY AT MT. ROYAL AND GUILFORD AVENUES, BALTIMORE, MD.
By THE JOURNAL OF DENTAL RESEARCH, Inc.
EDITORIAL OFFICE: 632 West 168th St., New York City
Made in United States of America

INTERNATIONAL ASSOCIATION FOR DENTAL RESEARCH

HONORARY OFFICERS (1934–'35). *Vice-Presidents*—Evelyn Sprawson, London. Hermann Wolf, Vienna. Jan Jesensky, Prague.

ACTIVE OFFICERS (1934–'35). *President*—J. L. T. Appleton, Jr., Univ. of Pennsylvania. *President-elect*—Theodore B. Beust, Univ. of Louisville. *Vice-president*—William G. Skillen, Northwestern Univ. *Treasurer*—Bissell B. Palmer, Fifth Avenue Hospital (New York City). *Secretary*—William J. Gies, Columbia University. *Trustees of the Endowment Fund*—The Treasurer; R. W. Bunting, Univ. of Michigan; A. D. Black, Northwestern Univ. *Acting Board of Editors*—The first five active officers.

THE SECTIONS—THEIR SECRETARIES, AND REPRESENTATIVES IN THE COUNCIL AND IN THE BOARD OF EDITORS (1934–'35)

Division	*Section*	*Secretary*	*Councillor*	*Editor*
Austria	Vienna	Fritz Driak	Balint Orban	Bernhard Gottlieb
Canada	Halifax	Hugh M. Eaton	G. K. Thomson	S. G. Ritchie
	Toronto	A. J. Broughton	A. J. McDonagh	A. J. McDonagh
	Winnipeg	E. Roy Bier	H. J. Merkeley	E. Roy Bier
China	Chengtu	R. Gordon Agnew	R. Gordon Agnew	R. Gordon Agnew
Czecho-slovakia	Prague	Friedr. Neumann	Friedr. Neumann	Jan Jesensky
England	London	Evelyn Sprawson	Evelyn Sprawson	Evelyn Sprawson
Hungary	Budapest	Ferenc Köszeg	Josef Szabo	Josef Szabo
S. Africa	Johannesburg	W. A. Wilson	Geoffrey Friel	J. C. M. Shaw
United States	Ann Arbor	U. G. Rickert	U. G. Rickert	U. G. Rickert
	Baltimore	M. S. Aisenberg	M. S. Aisenberg	A. H. Schultz
	Boston	Francis H. Daley	L. M. S. Miner	P. E. Boyle
	Chicago	James R. Blayney	V. T. Nylander	E. H. Hatton
	Cleveland	S. W. Chase	Thomas J. Hill	S. W. Chase
	Columbus	Paul C. Kitchin	Paul C. Kitchin	R. D. McFarland
	Louisville	Raymond E. Myers	T. B. Beust	T. B. Beust
	Minnesota	Harold G. Worman	Carl J. Grove	W. D. Armstrong
	New Haven	James P. Pigott	A. W. Crosby	S. S. Arnim
	New York	Theodor Rosebury	L. M. Waugh	Theodor Rosebury
	Philadelphia	Thomas J. Cook	Thomas J. Cook	Carrie K. Bryant
	Pittsburgh	L. E. Van Kirk	Kaethe Dewey	L. E. Van Kirk
	Richmond	J. C. Forbes	Harry Bear	J. C. Forbes
	Rochester	G. Van Huysen	H. J. Sedwick	H. C. Hodge
	San Francisco	W. B. Ryder	J. A. Marshall	J. A. Marshall
	St. Louis	C. O. Simpson	Geo. B. Winter	R. C. Wheeler
	Washington	G. C. Paffenbarger	Wilmer Souder	H. E. Harvey

SOCIETIES THAT ACTIVELY SUPPORT THE JOURNAL OF DENTAL RESEARCH, AND THEIR REPRESENTATIVES IN THE HONORARY BOARD OF EDITORS

First District Dental Society of the State of New York ..... JOHN OPPIE MCCALL
New York Academy of Dentistry ..... THEODOR ROSEBURY
American College of Dentists ..... ALBERT L. MIDGLEY, Providence
Academy of Stomatology (Philadelphia) ..... JOHN BURKHARDT, JR.
Allied Dental Council (New York) ..... LEON HARRIS
American Academy of Dental Science ..... CHARLES E. HATCH, Boston
American Stomatological Association:
H. J. LEONARD AND EDWARD FRANKEL, JR., New York City
Kings County (N. Y.) Dental Society ..... LEONARD KOHN
Odontographic Society (Chicago) ..... HOUSTON F. METHVEN
Robert R. Andrews Society for the Promotion of Research (Tufts) .... CHARLES E. HATCH

Copyright, 1935, by The Journal of Dental Research, Inc.
Entered as second-class matter June 24, 1919, at the Post Office at Baltimore, Maryland, under the act of March 8, 1879

HUMAN SALIVA

II. A Technical Procedure for Calcium Analysis[1]

W. W. WAINWRIGHT, D.D.S., M.S.

George Williams Hooper Foundation for Medical Research, and College of Dentistry, University of California, San Francisco, Calif.

Recently a survey of international literature concerning salivary Ca was made by Becks and Wainwright (3). They called attention to the inadequacy of present knowledge of the subject, and to the extreme variation of results reported by former investigators. It was found that salivary-Ca values published by 26 authors varied from 1.5 to 33 mg. percent. None of these investigators showed definite correlation between salivary-Ca content and dental disorders. The 26 authors who attempted to determine salivary-Ca content were divided into three groups: (a) 8 used methods no longer acceptable because technical procedures for Ca analysis have been greatly improved; (b) 8 did not satisfactorily report the technical procedures, making it impossible to judge the reliability of the findings; (c) 10 reported in detail the methods, which showed many differences in technic. These differences suggested a possible reason for the wide range of results. Only the data of Clark and Shell (5), Becks (1, 2), Karshan, Krasnow and Krejci (9), Krasnow (11), Leonard (12), and Horton, Marrack and Price (6), are useful in establishing normal standards. From a strictly scientific aspect, only the results of the five cases of Clark and Shell are acceptable. This unexpected finding indicated definite need for further thorough studies of salivary-Ca content. Becks and Wainwright (3) showed that the very wide range of results in previous work was due partly to the methods of Ca analysis, and partly to the basis on which subjects were selected. Differences that affected results occurred in preliminary treatments of saliva

[1] Conducted under grants made by the California State Dental Association, California Academy of Periodontology, Research Board of the University of California, and the Good Teeth Council for Children. Presented at the twelfth general meeting of the International Association for Dental Research, Chicago, March 17 and 18, 1934; *J. Den. Res.*, 1934, *14*, 171. Received for publication: April 23, 1934.

and in washing technics of these methods. It was demonstrated that these factors markedly influenced results. Therefore, it became necessary to develop a standard method of salivary analysis from which material error would be eliminated.

The first step toward establishing a standard technic was selection of a method of Ca analysis suitable for salivary work. Methods used for biological fluids were reviewed (3), and those of Halverson and Bergeim, and Kirk and Schmidt, selected on the basis of accuracy and speed. These two methods were tested on saliva according to technics suggested for blood serum, but the results did not check, owing to omission of deproteinization in the Kirk-Schmidt procedure. This was shown by check results when deproteinization was incorporated in both methods. Thus, deproteinization becomes one of the problems in developing preliminary treatment. Becks and Wainwright demonstrated that deproteinization is an essential part of preliminary treatment, even though preliminary centrifugation be employed. It had previously been shown by Horton, Marrack and Price (6), and Krasnow, Karshan and Krejci (10), that deproteinization could be substituted for the longer and more tedious dry-ashing.

The other problem in preliminary treatment concerns centrifugation. Its use or omission has been one of the most important differences among various salivary-Ca methods. In general, during preliminary treatment, materials which might interfere in subsequent parts of the determination must be removed; for example, debris and organic matter. Clark and Levine (4) decided to omit preliminary centrifugation because they always found a lower value when saliva was centrifuged before sampling. They interpreted this lower value to mean loss of Ca, and noted that it was accompanied by smaller loss of P, while chlorides remained constant. They explained the loss of Ca on the basis of possible precipitation in a Ca-P-mucin complex, this removal occurring during collection and centrifugation. The loss was reported as inconstant, varying from 6 to 18 percent in the averages of 35 determinations in salivas of two individuals. In each case they employed heat-ashing to destroy organic constituents. Becks (1) employed the additional step of preliminary centrifugation to remove debris and cells. He pointed out that this eliminated, as far as possible, any effect solid material might have on the result. Becks

and Wainwright, conducting tests similar to those of Clark and Levine, on saliva from one individual on four different days, partially confirmed the findings of Clark and Levine. When preliminary centrifugation was employed, lower results were usually obtained than when it was omitted. In one instance the methods gave an exact check. Because the loss was variable, it was explained on the basis of an irregular factor, which was supposed to be Ca-containing debris.

To test this conclusion, the present author analyzed centrifuged and uncentrifuged samples from ten different individuals. Viscosity, cell content, debris (when visible), character of protein precipitate, filtrate obtained after protein precipitation, general hygiene of mouth, age of patient, and rate of flow were noted. The analytic data are indicated in *table 1*. Samples 2, 3, 4, 6, 8 and 10 gave check results by both methods of preliminary treatment; for 1, 5, 7, and 9, the centrifuged samples were respectively 30, 20, 6, and 19 percent lower. The latter findings were tested on another day and three different results were obtained: for 9, the difference disappeared and the two methods gave check results; for 1, the original difference was duplicated exactly; for 5, the difference not only remained but increased markedly (in the first examination the centrifuged sample was 20 percent lower; in the second, 37 percent). It is remarkable that so many of these samples showed no change in Ca content of the centrifuged saliva. In view of Clark and Levine's report of consistent loss, a difference greater than that allowed for experimental error would be more frequently expected. Certainly these tests give a very different picture of the extent to which centrifugation influences *loss* of Ca. The occurrence or magnitude of a loss in the centrifuged samples could not be correlated in these ten cases with any of the general properties noted above.

If Ca were removed, during collection and centrifugation, by precipitation as a Ca-P-mucin complex, as suggested by Clark and Levine, it would be reasonable to expect this to occur consistently, particularly in different samples of saliva of a single individual. The results obtained by Clark and Levine, do not, however, present a single case in which the difference remains constant; and only one case among ten in the present paper showed the same differences in second examinations. Clark and Levine interpreted their findings by saying that Ca "was consistently lower in the centrifuged samples . . . ., the

loss varying from 6 to 18 percent, and only once approximated the experimental error of the method." This does not exactly describe their original data (charts, page 266), which indicate that loss was not consistent, but extremely variable. For example: for the 9:15 a.m. sample, case C.B., Nov. 13, 1925, the two methods gave very close checks. In chart 4, results by the two methods differ as much as 39 percent. These findings, shown throughout charts 1 to 6 (for P as well as Ca), exactly duplicate results noted here, in *table 1*. The statement that Ca was consistently lower in centrifuged samples *is true only of average values*. This is to be expected of averages, as there is no possibility

TABLE 1

Results of salivary-Ca analysis, with and without preliminary centrifugation[1]

PRELIMINARY TREATMENT: DEPROTEINIZATION	PATIENT												
	1	2	3	4	5	6	7	8	9	10	Checks		
											1	5	9
	Mg. per cent of Ca												
With centrifugation	6.14	6.05	5.44	6.54	5.04	5.95	7.36	5.70	6.16	7.06	6.11	6.55	6.35
	6.14	6.15	5.44	6.54	4.84	5.95	7.56	5.70	6.16	7.36	6.31	6.45	6.45
Without centrifugation	8.98	6.25	5.24	6.14	6.14	6.35	7.96	5.86	7.58	7.21	8.45	10.38	6.65
	8.58	6.35	5.49	6.54	6.24	6.20	7.96	5.96	7.53	7.76	8.65	10.18	6.55

[1] Modification of the Halverson-Bergeim method.

(except by accident) of increasing the Ca content of a centrifuged, and consequently clear, sample of saliva over the amount originally in solution.

These irregular and somewhat infrequent lower results are more readily explained by presence of Ca-containing debris. This possibility is obvious, considering the ease with which particles may be washed from the mouth during collection of saliva. Food such as milk, also other debris, may be quite high in Ca. Dentifrices contain large quantities of Ca either as carbonate or phosphate. Of course, the selected method of removing debris should not take away any of the dissolved Ca. Only a small amount of Ca (in debris, etc.) need be added to give an increased value when centrifugation is omitted. The weight of Ca from 2 cc. of saliva, in a single determination—if in a concentration of 10 mg. percent—is only 0.2 mg. (0.0002 gram).

It seems, then, that the lower values—occasionally obtained when preliminary centrifugation is employed—are really not low, so far as may be determined from data now available. Instead, they represent values closer to actual amounts of Ca *in solution* in saliva than the higher ones obtained without centrifugation, and therefore give the most useful picture of Ca content. For these reasons, preliminary centrifugation must be recommended for all future salivary analyses as first suggested by Becks (1). This conclusion was confirmed in a series of analyses which tested the recovery of added amounts of Ca.

The amounts added to saliva samples, in the form of neutral solution of $CaCl_2$, were sufficient to raise the concentration of Ca exactly

TABLE 2

Recovery of known amounts of Ca added to samples of saliva

PATIENT	MODIFIED METHOD OF HALVERSON AND BERGEIM				MODIFIED METHOD OF KIRK AND SCHMIDT			
	Saliva		Recovery		Saliva		Recovery	
	Ca mg. %	+4.5 mg. % Ca	mg. % Ca	%	Ca mg. %	+4.5 mg. % Ca	mg. % Ca	%
207	4.64	9.33	4.65	103	5.14	9.81	4.50	100
	4.74	9.33			5.04	9.41		
173	3.83	8.36	4.60	102	3.63	8.37	4.65	103
	3.73	8.46			3.53	8.17		
187	3.43	7.87	4.35	97	3.43	8.68	4.45	99
	3.43	7.77			3.43	7.16		
246	4.85	9.40	4.55	101	4.45	8.90	4.35	97
	4.75	9.30			4.74	9.00		

4.5 mg. percent in each case. The data are given in *table 2*. In four samples of saliva, recovery varied between 4.35 mg. and 4.65 mg. percent. Deviation from actual amounts of added Ca varied between + 3 and −3 percent. These findings demonstrate clearly the accuracy of the recommended procedures, and furnish conclusive evidence for their adoption.

In order that there may be no misunderstanding concerning preliminary treatment and washing technic in salivaryanalysis, the modifications of the methods of Halverson and Bergeim (13), and Kirk and Schmidt (8), which have been adopted for routine use, are described below in detail.

RECOMMENDED METHOD

Collection of saliva. The patient is instructed to eat no breakfast, and to drink no water or other liquid, the morning the sample is taken. The appointment is made for 8:00 or 8:30 a.m. The patient is requested to avoid yawning, swallowing, spitting, or any other stimulation. Saliva is taken with the patient undisturbed and at rest. With head tipped forward and mouth opened, saliva is allowed to drip through a funnel into a graduated tube. For duplicate Ca analyses, about 8 to 10 cc. are collected under oil. The sample is placed in the ice chest until needed.

1. *Preliminary centrifugation.* The saliva is sampled within two hours after collection. About 8 or 9 cc. are centrifuged at *high speed* under oil, routinely for 20 minutes; some thick salivas, however, require more time or higher speed. The clear liquid is siphoned off with a pipette having an upturned tip, and transferred to a dry tube. It is well to avoid bringing over oil at this time as it interferes in subsequent steps.

2. *Deproteinization.* Six cc. of saliva are transferred to a 50-cc. Erlenmeyer flask to which 6 cc. of 10 percent trichloracetic acid are added. This is thoroughly mixed and allowed to stand for 10 minutes.

3. Then, without disturbing the precipitate, which has settled to the bottom, filter through ashless paper (Whatman's #42). If the sample should filter slowly, the process may be hastened by applying mild suction (with the aid of a suction flask). The technic of Krasnow, Karshan, and Krejci (10), in which the precipitate is separated by centrifugation before filtering, appears to be satisfactory also.

4. Two 4-cc. samples of filtrate (corresponding to 2 cc. of saliva) are taken for duplicate determinations; the remainder is saved for P determinations. The 4-cc. portions are transferred to conical 15-cc. pyrex centrifuge-tubes, which must drain well.[2] (For the Kirk-Schmidt method, round-bottom test-tubes, $\frac{5}{8}$″ or $\frac{1}{2}$″ by 4″ or 5″ may be used.)

5. Slowly add 1 cc. of 4 percent $(NH_4)_2C_2O_4$, being careful that none is allowed to get on the upper part of the tube.

6. Add 2 drops of 0.04 percent brom-cresol-green and mix. Add 1:1 NH_4OH till the color on mixing just turns from yellow to greenish blue.[3]

7. Whirl the contents by tapping the tube at the bottom; cover with tin foil or a cork stopper, and allow to stand for 2 hours—if over night, place in an ice box.

[2] See Peters and Van Slyke: Quantitative clinical chemistry; Vol. 2, Methods; p. 769, paragraph 3.

[3] See Peters and Van Slyke, p. 769.

8. *Washing technic.* A. When the Halverson-Bergeim method (13) is used, the procedure as described by Peters and Van Slyke (13, p. 771) is followed. For the first centrifugation of precipitate, a speed of about 2,000 revolutions per minute for 20 minutes is used. The second and third centrifugations are carried out at about the same speed, but for only 5 minutes each.

B. (a) The Kirk-Schmidt washing technic was modified slightly from that originally described (8). The asbestos was not washed (7), and a thicker pad (about 2–3 mm.) was made. The pad should be so adjusted that the solution (when suction is off) will not pass through for several minutes, or at least very slowly. However, the pads should not be thicker than 3 mm., so that they will not hold too much wash-liquid. The process should not be too slow. If about nine (rather than fewer) holes are made in the platinum disk, filtration is aided. This pad is used repeatedly, and cleaned and washed between analyses. The *funnel* as described (8) did not fit into the mouth of the test tube far enough to prevent splashing and loss of acid when the precipitate was dissolved. This may be remedied by using a funnel with a longer stem, or by tying the test tube so that contact with the bottom of the stopper will be assured. The end of the tying string hangs over the edge of the flask, fixing the tube when the filter in its rubber stopper is brought to place. Also, suction flasks may be purchased in such sizes that the tube may rest conveniently on the bottom and still be high enough to avoid spattering and loss. The *filters* are prepared, before use, by placing test tubes under each in the suction flask and filling with hot (100°C.) chromate-sulphuric-acid cleaning solution. Strong suction is applied. After the acid has gone completely through, the tubes in which it was collected are removed. The filters are very thoroughly washed about five times with distilled water, with the aid of suction. The filtrate is poured from the suction flask, which is washed free from acid and rinsed with distilled water. The outside of the filter-stem is also rinsed with distilled water. The filters are returned to the flasks, and finally washed twice with the wash liquid (1:50 NH_4OH saturated with CaC_2O_4).

(b) The covers of the test tubes containing the samples are removed, and a thin film of vaseline is placed on about $\frac{1}{3}$ to $\frac{1}{2}$ the circumference of the lip. The liquid is stirred and poured onto the filter pad, care being taken not to splash the liquid. Apply suction. During the entire washing procedure, the liquids should be poured out at the same place on the lip.

(c) The sides of the tube are then washed-down thoroughly; wash-water and precipitate are mixed, poured onto the filter, and suction applied. Repeat twice more. The amounts of liquid used are respectively about

8 to 10, 6, and 3 cc. After pouring the last portion, the tube is well drained and the last drop shaken out. A wash-bottle is used, as suggested by Kirk and Moberg (7).

(d) The sides of the filter are well washed-down with about 5 cc. of wash-liquid.

(e) After the last bit of wash-liquid has been sucked through, the filter in its stopper is removed, and the wash-liquid remaining inside and any outside the stem are absorbed by filter paper. The inside of the mouth of the suction flask is wiped dry, the original tube hung inside, and the funnel and stopper replaced.

(f) Without suction the precipitate is dissolved on the filter-pad by washing-down the sides of the funnel with 2 cc. of hot 2*N* H_2SO_4 (heat cautiously to just below boiling point). Let it stand for five minutes; then with suction collect the acid below. Remove suction, and wash the funnel with 1 cc. of hot 2*N* H_2SO_4. Let it stand two minutes and again apply suction. Repeat once more with 1 cc. of acid. After the last drop of acid has been sucked through, remove the tubes from the suction flasks.

9. The titration of the oxalate with 0.01*N* $KMnO_4$ is carried out with great care according to the technic described by Peters and Van Slyke (13). *Reagents:* (a) Paraffin oil. (b) 10 percent trichloracetic acid (Merck's). (c) 4 percent $(NH_4)_2C_2O_4$ (saturated). (d) 0.04 percent brom-cresol-green in 95 percent ethyl alcohol. (e) 1:1 NH_4OH. (f) Cleaning solution: 1 gram of potassium bichromate to 100 cc. of concentrated H_2SO_4 (technical grade). Heat cautiously to 100°C. to aid solution of the chromate. (g) The wash-liquid used in the Kirk-Schmidt method is prepared by saturating 1:50 NH_4OH with CaC_2O_4.[4] For the Halverson-Bergeim method, plain 1:50 NH_4OH is used. (h) 2*N* H_2SO_4 : 56 cc. concentrated H_2SO_4 per liter. (i) 0.01*N* $KMnO_4$. (j) 0.01*N* $Na_2C_2O_4$.

SUMMARY

1. A recent survey of international literature revealed the inadequacy of present knowledge of salivary-Ca content. The wide range of results was shown to be due in part to the methods employed for Ca analysis; in part, to the basis on which subjects were selected for examination.

[4] For detailed information on standardization of this reagent, the reader is referred to Peters and Van Slyke (Quantitative clinical chemistry; Vol. 2; Methods, page 772). Thorough washing of the CaC_2O_4 before use is stressed. One commercial salt used in the preparation of this reagent gave a wash-liquid with a high titration figure, which could not be lowered by any amount of filtration. After washing with dilute ammonia, the product gave a satisfactory solution.

2. In order to establish a standard procedure for salivary analysis, the methods of Ca determination, as used on biological material, were reviewed and modifications of the procedures of Halverson and Bergeim, and Kirk and Schmidt, were developed and found to be most suitable.

3. Previous tests of preliminary treatment showed the necessity for deproteinization. Recent work has indicated that the saliva should also be centrifuged.

4. The author tested different types of saliva from ten subjects for the influence of preliminary centrifugation. In six no effect was found, disaffirming the observation of Clark and Levine that there was a "consistent" loss of Ca in centrifuged samples.

5. The original data of Clark and Levine showed that this observation was not true of all single determinations, but only of certain averages. Thus the results of Clark and Levine, Becks and Wainwright, and the author, agree in proving that the lower values in centrifuged samples, as compared with uncentrifuged ones, occur only occasionally and always irregularly.

6. Preliminary centrifugation is recommended for a standard method because irregularly low results are apparently due to inclusion of Ca-containing debris.

7. Known amounts of Ca, added to saliva samples, were satisfactorily recovered. These findings demonstrate clearly the accuracy of the recommended procedures, and furnish the conclusive evidence required for their adoption.

8. Detailed descriptions are given of the technical procedures for salivary-Ca determination, according to modifications of the methods of Halverson and Bergeim, and Kirk and Schmidt.

REFERENCES TO LITERATURE

(1) BECKS, H. Ergebnisse neuerer Speichel-Untersuchungen mit besonderer Berücksichtigung der Gravidität und der Paradentosen; Hermann Meusser; Berlin, 1929.

(2) —— Electrolytes of saliva under normal and pathological conditions, *Proc. Soc. Exp. Biol. and Med.*, *26*, 93; 1928.

(3) BECKS, H., AND WAINWRIGHT, W. W. Human saliva: (I) Critical discussion of former salivary calcium studies and their value in the establishment of normal standards, *J. Den. Res.*, *14*, 387; 1934.

(4) CLARK, G. W., AND LEVINE, L. Inorganic constituents of human saliva (II), *Amer. J. Physiol.*, *81*, 264; 1927.

(5) CLARK, G. W., AND SHELL, J. S. The influence of diet upon the inorganic constituents of human saliva, *Dent. Cosmos*, *69*, 500, 605; 1927.

(6) HORTON, K., MARRACK, J., AND PRICE, I. The relation of calcium in the saliva to dental caries, *Biochem. J.*, *23*, 1075; 1929.

(7) KIRK, P. L., AND MOBERG, E. G. Microdetermination of calcium in sea water, *Ind. and Eng. Chem.*, *5*, 95; 1933.

(8) KIRK, P. L., AND SCHMIDT, C. L. A. An improved technique for micro calcium-analysis, *J. Biol. Chem.*, *83*, 311; 1929.

(9) KARSHAN, M., KRASNOW, F., AND KREJCI, L. E. A study of blood and saliva in relation to immunity and susceptibility to dental caries, *J. Den. Res.*, *11*, 573; 1931.

(10) KRASNOW, F., KARSHAN, M., AND KREJCI, L. E. The determination of calcium and phosphorus in saliva, *J. Lab. and Clin. Med.*, *17*, 1148; 1932.

(11) KRASNOW, F. Biochemical studies of dental caries: diurnal variations in the P, Ca, H-ion concentration, and titratable alkalinity, *J. Dent. Res.*, *12*, 530; 1932.

(12) LEONARD, H. J. The causes of variation in salivary calcium; their relation to susceptibility and immunity to dental caries, *J. Amer. Den. Assoc.*, *15*, 1530; 1928.

(13) PETERS, J. P., AND VAN SLYKE, D. D. Quantitative clinical chemistry; Vol. II, Methods; Williams & Wilkins Co.; Baltimore, 1932.

STUDIES ON THE CHEMISTRY OF MIXED HUMAN SALIVA

I. Attempts to Correlate Chemical Composition of Mixed Human Saliva with Rate of Secretion[1]

J. B. BROWN, Ph.D., and N. J. KLOTZ, B.S.

Laboratory of Physiological Chemistry, Ohio State University, Columbus, Ohio

There have been numerous researches in salivary chemistry. Those concerned with human saliva have been motivated principally by three general interests: physiology of salivary secretion; use of salivary analysis in medical diagnosis; and composition of saliva as a factor in the etiology of dental caries. The data presented below were obtained incidentally in the course of a general investigation, now under way in this laboratory, on the saliva in relation to its action on dental restoratives.

In a routine class-experiment, 88 first-year medical students collected saliva while chewing paraffin for two consecutive 15-minute periods, and reported the volumes of saliva secreted during that time. The average volume obtained during the first period was 36 cc.; during the second period, 31 cc.; during the two periods, 67 cc. There was six-fold variation in the total 30-minute volume ranging from 23 to 138 cc. This wide variation interested us in the problem as to whether salivas secreted at widely different rates were similar in composition; or whether, for example, salivas produced at slow rates were more concentrated than those produced much more rapidly.

Outline of experiment. From the students mentioned above, three groups of six each were selected on the basis of their rate of production in the aforesaid class-experiment.[2] The three groups, thus obtained, are henceforth designated as "low-producing," "medium-producing," and "high-producing." It is interesting to note that of the eighteen men chosen, only one

[1] We are indebted to the Columbus Dental Manufacturing Company for a grant to defray part of the expense of this research.

[2] We deeply appreciate the coöperation of these students, without which we could not have carried on this research.

failed to fall into his group class, necessitating selection of another in his place. It is apparent, therefore, that there is general constancy of response to paraffin chewing from day to day. The groups of students were segregated on different mornings (9 a.m.) in a private room, and under supervision chewed paraffin for one hour. We noted volumes for 15-minute periods, as well as total volumes. As much saliva as possible was obtained during the period. Mixed saliva from each individual was analysed colorimetrically for pH immediately, although loss of CO_2 during collection tended to make this result generally high. Other analyses were made when convenient, the specimens being preserved in a refrigerator at 0°–5°C. The *methods of analysis* follow: *Total solids:* 5 cc. specimens were evaporated to dryness at 100°C., final heating to constant weight being carried out under reduced pressure. *Chloride:* Whitehorn method for blood chlorides (1) on whole saliva, without removing organic matter. *Ash:* total solids ashed at dull-red heat (not above 650°C.) *Phosphate:* method of Youngburg and Youngburg (2). It was necessary to prolong digestion with perhydrol for several hours, to avoid all yellow-color formation. Results are reported as total phosphate. *Total nitrogen:* micro-method of Folin and Wu (3). The results appear in *table 1.*

Discussion. It is not our intention to refer, in this preliminary report, to the numerous previous investigations of the chemistry of saliva. There are relatively few papers on the quantitative analysis of mixed human saliva. None of these has attempted to correlate rate of secretion with composition. In such a study many factors are involved, depending upon the great complexity of the physiology of salivary secretion. In our selection of the components of saliva for analysis, we were guided mainly by our interest in other investigations, as already indicated. In this work not enough cases have been studied to permit a statistical analysis of the results. Hence in evaluating them, only differences far above the probable experimental error will be regarded as significant.

Rate of secretion.—In general there was slight but gradual decrease in rate of secretion over the four 15-minute periods. *H-ion concentration.*—There were no significant group differences in pH. This value was higher than that previously reported in several recent investigations for so-called normal human saliva. The reason, no doubt, lies in the fact that all our specimens were centrifuged before analysis. They were also allowed to stand during the period of collection, which

unavoidably resulted in loss of CO_2 and rise in pH. *Total solids and ash.*—There were no important differences in total solids and ash of the three groups. The "high-producing" group was, if anything, slightly more concentrated. *Phosphates.*—Our values agree well with

TABLE 1

Analysis of mixed human salivas secreted at widely different rates

Subject	Volume					pH	Cl	PO_4	Total N	Solids	Ash
	1st 15 min.	2nd 15 min.	3rd 15 min.	4th 15 min.	Total 1 hr.		Mg. per 100 cc.				
	cc.	cc.	cc.	cc.	cc.					per cent	per cent
"Low-producing" group											
1 H. G.	13.0	8.0	8.0	9.5	38.5	7.5	40	54.9	....	0.42	0.10
2 A. D. C.	11.5	9.0	8.0	8.5	40.0	7.4	52	60.0	....	0.60	0.14
3 D. W.	13.0	9.5	10.5	12.0	40.0	7.6	27	60.0	....	0.39	0.13
4 R. F. D.	15.0	10.0	17.5	13.0	55.5	7.0	35	36.6	75.0	0.53	0.17
5 T. W. S.	17.0	13.0	14.0	15.5	59.5	7.3	41	47.4	55.9	0.58	0.10
6 R. E. T.	30.0	22.0	27.0	20.0	99.0	7.5	39	45.6	41.6	0.43	0.13
Average	*16.6*	*11.9*	*14.1*	*13.1*	*55.9*	...	*39*	*50.7*	*57.5*	*0.49*	*0.13*
"Medium-producing" group											
7 H. J. C.	33.0	34.0	33.0	32.0	132.0	7.5	88	34.2	57.4	0.68	0.22
8 H. C. K.	37.4	32.5	33.9	31.5	135.3	7.4	35	42.0	43.2	0.45	0.14
9 F. E. W.	32.3	33.2	35.7	35.3	136.5	7.5	72	34.8	27.1	0.46	0.13
10 P. D.	41.5	28.5	36.0	34.5	140.5	7.6	35	64.8	31.2	0.42	0.13
11 W. B. H.	42.5	36.5	35.7	36.7	151.4	7.3	54	39.3	39.4	0.44	0.14
12 P. H.	40.0	35.0	40.0	40.5	155.5	7.3	24	44.7	25.9	0.32	0.12
Average	*37.8*	*33.3*	*35.7*	*35.1*	*141.9*	...	*51*	*43.3*	*37.4*	*0.46*	*0.14*
"High-producing" group											
13 M. W. S.	45.0	52.0	46.0	35.0	178.0	7.6	67	37.2	47.3	0.51	0.19
14 H. C. M.	58.0	55.0	50.0	49.0	212.0	7.2	54	33.1	37.5	0.42	0.18
15 W. I. W.	60.0	71.0	63.0	53.0	247.0	7.4	42	24.3	35.6	0.51	0.24
16 C. B. R.	69.0	71.0	61.0	62.0	263.0	7.1	100	45.3	66.3	0.70	0.15
17 R. D.	82.0	74.5	65.5	78.0	300.0	7.3	50	45.9	31.9	0.39	0.10
18 J. M.	75.0	84.0	75.5	76.0	310.5	7.5	67	40.7	41.4	0.53	0.10
Average	*64.9*	*67.9*	*60.2*	*58.8*	*251.7*	...	*63*	*37.2*	*43.3*	*0.51*	*0.16*

those reported by Youngburg (4). Phosphates were most concentrated in the "low-producing" salivas, decreasing as secretion-rate increased. *Chloride* was least concentrated in the "low-producing" group, highest in the "high-producing group." There was a very

general inverse relationship between chloride and phosphate, which may be expressed by the equation:

$$C_{Cl} \times C_{PO_4} = K$$

where C_{Cl} is the concentration of chloride and C_{PO_4} the concentration of phosphate. Expressing concentrations in mg. per 100 cc., the average value for K, for the "low-producing" group, was 1990; for the "medium-producing" group, 2075; for the "high-producing" group, 2494; for the entire group, 2183. The value for K tended to rise somewhat with rate of secretion, but variations in individual cases were very great; therefore the reasonably close agreement of average values for K, for the three groups, loses significance. Further work will be necessary to establish this relationship beyond reasonable doubt. *Total nitrogen* in the "low-producing group" was above that in either of the other two groups. Whether this was due to higher content of mucin, or of non-protein nitrogen, was not determined.

It is apparent that the only values that were significantly variable with rate of secretion were those for total nitrogen, chloride, and phosphorus. There seemed to be compensation between the latter two, low chloride being usually accompanied by high phosphate, and vice versa.

Summary. (1) Mixed salivas from three groups of six men each, who naturally produced salivas at widely different rates, were examined for several chemical constituents.

(2) Average concentrations of total solids and ash showed only slight differences, the "high-producing" group being the most concentrated.

(3) Total nitrogen of the "low-producing" group was decidedly higher than that of the other two groups.

(4) Phosphate and chloride showed significant variations. "Low-producing" salivas were high in phosphate and low in chloride, while "high-producing" salivas were high in chloride and low in phosphate

REFERENCES TO LITERATURE

(1) WHITEHORN, J. C.: *J. Biol. Chem.*, *45*, 449 (1921).
(2) YOUNGBURG, G. E., AND YOUNGBURG, M. V.: *J. Lab. Clin. Med.*, *16*, 158 (1930).
(3) FOLIN, O., AND WU, H.: *J. Biol. Chem.*, *38*, 90 (1919).
(4) YOUNGBURG, G. E.: *J. Den. Res.*, *12*, 267 (1932).

RELATION OF DENTAL CARIES TO DISEASE, MENSTRUAL EXPERIENCE, AND PHYSICAL MEASUREMENTS OF YOUNG WOMEN[1]

RUBY L. CUNNINGHAM, M.D.

Ernest V. Cowell Memorial Hospital, University of California, Berkeley, Calif.

It is possible that dental caries may be but one of a number of disorders due to a common cause. The discovery of concomitant defects would increase the pathological significance of dental caries. On the other hand, if this widespread disease were proved to be unassociated with other physical defects or functional disorders, it would add weight to the argument that the cause is of oral rather than systemic significance. With these possibilities in mind, this comparison of the histories and physical measurements of young women with few damaged teeth and young women with many damaged teeth was undertaken.

Every student entering the University of California is given a complete physical examination, which includes a dental examination made by a dentist. A medical history is also taken. A discussion of the methods and accuracy of the examination and history was given in a previous report, as was also the punch-card method of gathering and handling data.[2] Record cards of 11,117 women from 15 to 19 years of age were available for this study. Many of these young women had not yet erupted the third molars and, since it is difficult to discover from history or inspection whether third molars have been extracted or not, the study is based upon the condition of the remaining twenty-eight teeth. Fillings and cavities in third molars were not counted or included in the data presented. The term, damaged teeth, refers to teeth with cavities, fillings, or crowns. A tooth with one filling or more is counted as one damaged tooth. In two thousand five hundred and sixty-two (2,562) of the 11,117 students one or more of the twenty-

[1] A statistical report. Aided by a grant from the Research Board of the University of California.

[2] Cunningham, Ruby L.: Normal, absent and pathologic tonsils in young women; a comparison of histories. *Arch. Int. Med.*, 1931, *47*, 513.

eight teeth were missing. Failure to develop and erupt the normal number of teeth, and the extraction of sound teeth to correct crowding or alignment, account for a number of these. The larger number, undoubtedly, were extracted because of decay or its sequelae. If the study were to be repeated, all extracted teeth would be included in the category of damaged teeth; or the study would be limited to those students with twenty-eight teeth present, not including third molars.

The punched cards were separated into six groups, according to the number of damaged teeth recorded: (1) none, (2) less than five, (3) five to nine, (4) ten to fourteen, (5) fifteen to nineteen, and (6) twenty or more. These were then sorted for facts of history and physical measurements. Results are presented in *tables 1* and *2*.

The 381 cards of students with no damaged teeth shown in column 1 of both tables are also included in column 2 (0–4 damaged teeth). Since the numbers of those with none and those with 20 or more are small, probably errors of percentage-incidences recorded for them are large. When a variable—history of a disease, symptom, body function, or physical measurement—showed a consistent increase, or decrease in percentage incidence from the group with no damaged teeth to the group with twenty or more, the cards were regrouped into two categories: those with less than ten, and those with ten or more, damaged teeth. The difference between the percentage incidences in these two categories was then compared with the standard error of the difference of the two percentages. It is customary to expect that before the influence of chance is excluded, the difference between the percentage incidence of two variables shall be greater than twice the standard error. A more conservative guarantee of reliability is established when the percentage difference exceeds three times the standard error. In this study there are few instances in which there is a direct or inverse progression of a variable with the number of damaged teeth. In no instance does the percentage difference between a variable in the group with less than ten damaged teeth, and the same variable in the group with ten or more, exceed three times the standard error.

The percentage incidences of the *infectious diseases of childhood* vary considerably in the six selected groups, but in no instance do they progress either directly or inversely as the number of damaged teeth. Furthermore, when the cards are regrouped into those with less than

ten and those with ten or more damaged teeth, the percentage incidences of the two groups do not differ significantly. This would

TABLE 1

Damaged teeth in relation to disease, symptoms, and menstrual experience, of 11,117 women from 15 to 19 years of age

CONDITION OF STUDENTS	DAMAGED TEETH						
	None*	0–4	5–9	10–14	15–19	20	Total
History of diseases and symptoms							
Measles (%)	88.1	90.9	82.5	82.9	90.2	91.5	85.2
Mumps (%)	48.6	47.5	47.2	47.5	50.7	52.5	48.3
Chickenpox (%)	64.8	65.4	59.8	59.2	66.4	59.9	61.4
Whooping cough (%)	67.2	71.1	61.4	60.2	67.8	70.3	63.0
Scarlet fever (%)	15.7	13.7	12.2	12.0	15.1	14.3	12.7
Diphtheria (%)	5.2	5.7	4.7	5.6	7.6	5.9	5.5
Small pox (%)	6.6	4.6	2.2	2.7	2.4	4.0	3.0
Pneumonia (%)	12.3	11.4	10.6	10.9	9.3	12.4	10.7
Chronic colds (%)	7.1	5.0	6.1	4.9	5.6	6.4	5.4
Influenza (%)	52.7	48.3	48.7	47.7	46.8	42.6	48.0
Tonsillitis (%)	22.5	25.7	25.8	27.1	25.2	26.7	26.0
Otitis media (%)	5.2	3.8	4.4	3.8	4.3	3.4	4.1
Constipation (%)	9.4	8.4	7.2	11.0	7.7	4.0	7.6
Headaches (%)	15.2	14.2	15.5	13.6	12.4	7.0	14.2
Number: diseases and symptoms	381	2102	4291	3211	1311	202	11,117
Menstrual experience							
Began before 14 yrs. (%)	62.8	65.8	65.1	63.6	61.9	62.8	64.6
Began after 14 yrs. (%)	36.8	34.0	34.8	36.3	38.1	37.1	35.2
Lasted less than 5 days (%)	43.5	37.7	37.4	35.4	36.2	37.7	36.7
Lasted 5 days (%)	31.7	39.3	39.5	39.4	40.7	40.7	39.7
Lasted more than 5 days (%)	24.8	22.9	23.1	25.1	23.1	22.1	23.6
Scanty flow (%)	3.0	2.9	3.2	3.2	3.2	5.3	3.1
Profuse flow (%)	5.2	5.9	6.3	6.4	6.9	3.7	6.1
Normal flow (%)	91.7	91.2	90.4	90.3	89.9	91.0	90.5
Slight dysmenorrhea (%)	31.1	26.8	26.4	26.1	28.0	23.1	26.6
Severe dysmenorrhea (%)	13.1	15.4	16.9	17.9	16.2	16.4	16.8
Number: menstrual experience	376	2102	4275	3196	1308	199	11,084

* Also included in 0–4 damaged teeth (next column).

indicate that the factor which predisposes to dental caries does not influence resistance to the infectious diseases of childhood. Since the

exanthematous diseases are often thought to damage teeth, it may be well here to include the statement that this study does not indicate

TABLE 2

Damaged teeth in relation to physical measurements of 11,117 women from 15 to 19 years of age

CONDITION OF STUDENTS	DAMAGED TEETH						
	None*	0–4	5–9	10–14	15–19	20	Total
Number of individuals; total	381	2102	4291	3211	1311	202	11,117
Short; less than 63 in. in height (%)	34.6	36.3	32.7	31.0	27.0	18.0	32.0
Medium; 63–64 in. in height (%)	35.1	33.8	34.7	34.6	35.1	28.8	34.4
Tall; over 64 in. in height (%)	30.0	29.9	32.6	34.4	38.5	52.9	33.6
Number: stature	375	2039	4181	3102	1269	191	10,782
Underweight; 10 lbs. or more (%)	29.9	31.4	31.5	29.3	30.6	24.2	30.6
Medium; + 10 lbs. to −10 lbs. (%)	55.5	52.1	51.1	51.0	49.8	56.8	51.2
Overweight; 10 lbs. or more (%)	14.4	16.6	17.4	19.7	19.6	18.9	18.2
Number: weight correction	372	2031	4173	3103	1251	190	10,748
Chest capacity; less than 29 cu. in. (%)	39.3	37.6	39.8	39.3	36.9	29.8	38.8
Chest capacity; 29–33 cu. in. (%)	39.3	38.0	36.3	37.0	36.1	38.8	36.8
Chest capacity; over 33 cu. in. (%)	21.4	24.4	23.9	23.6	27.2	31.3	24.4
Number: chest capacity	285	1530	3478	2504	972	134	8618
Posture; good: A and B (%)	27.7	28.9	28.0	27.7	26.3	22.1	27.8
Posture; medium: C (%)	56.7	56.7	57.1	59.7	58.9	60.0	58.0
Posture; poor: D and E (%)	15.6	14.4	14.9	12.6	14.4	17.9	14.1
Number: posture	307	1706	3535	2529	996	145	8911
Arches of the feet; high (%)	16.1	16.8	16.5	15.9	18.1	11.0	16.5
Arches of the feet; medium (%)	79.5	76.5	77.0	76.7	75.4	78.1	76.6
Arches of the feet; low or flat (%)	4.2	6.7	6.4	7.4	6.3	10.7	6.8
Anterior foot-arch; present (%)	82.6	77.5	75.4	76.3	79.0	70.5	76.6
Number: arches of the feet	353	1728	2903	2193	1234	187	8245
Nasal cavity; normal (%)	65.7	67.6	68.8	64.9	61.9	62.9	66.5
Nasal septum; deviated (%)	20.2	21.5	21.0	20.3	23.0	22.8	21.1
Number: nasal structures	379	2076	4259	3181	1299	200	11,015
Complexion; blond (%)	19.1	20.0	21.0	20.2	24.6	21.2	21.0
Complexion; demi-blond (%)	52.4	47.9	47.6	47.4	46.6	41.8	47.4
Complexion; brunette (%)	28.2	32.1	31.4	32.2	28.4	37.0	31.5
Acne; face (%)	9.7	11.1	10.6	9.9	9.3	12.8	10.7
Acne; chest (%)	11.0	12.5	12.1	10.8	11.7	12.8	12.1
Acne; back (%)	17.5	19.1	17.7	17.3	19.5	21.8	18.6
Number: complexion and acne	371	2052	4198	3104	1267	189	10,810
Cervical glands; palpable (%)	21.7	23.6	24.0	24.3	21.7	22.7	23.5
Thyroids; normal (%)	74.4	74.9	75.0	74.4	76.6	76.7	75.0
Thyroids; slightly enlarged (%)	21.2	22.0	22.7	23.8	21.1	23.8	22.8
Thyroids; with adenomata (%)	4.2	2.5	2.3	1.8	2.2	0.2	2.2
Number: cervical glands and thyroids	381	2094	4261	3197	1302	197	11,051
Blood-pressure; below 110 mm. Hg. (%)	36.5	31.2	30.6	30.3	27.3	28.6	30.2
Blood-pressure; 110–130 mm. Hg. (%)	33.4	33.8	33.1	33.7	35.1	32.5	33.6
Blood-pressure; above 130 mm. Hg. (%)	29.5	35.1	36.2	35.9	37.6	38.8	36.1
Number: blood-pressure	379	2094	4284	3217	1320	200	11,115
Tonsils; normal (%)	34.6	32.1	30.7	30.4	32.0	34.1	31.4
Tonsils; absent (%)	29.3	30.7	36.7	32.8	33.8	34.6	34.3
Tonsils; pathologic (%)	23.8	25.7	21.3	21.3	17.9	18.3	21.7
Number: tonsils	379	2076	4259	3181	1299	200	11,015
Vision; 20/20–20/20, both eyes (%)	59.8	62.5	59.2	59.9	59.2	56.0	60.0
Far-sighted (%)	23.8	20.2	21.3	20.3	22.0	25.1	20.9
Near-sighted (%)	15.4	17.2	19.3	19.7	18.7	18.8	19.0
Wear glasses (%)	30.9	29.3	30.9	30.7	30.0	32.1	30.5
Number: vision	361	2002	4097	3080	1237	191	10,607

* Also included in 0–4 damaged teeth (next column).

that *measles* or *scarlet fever* predispose to dental caries. Those who are subject to *colds*, those who have had *pneumonia*, *influenza*, *tonsillitis*, or *otitis media*, were found in approximately equal percentages in all classifications. Thus, dental caries and diseases of the respiratory tract do not seem to have a common cause. The age at which *menstruation* begins, its duration, amount of flow, and degree of pain seem to be independent of the condition of the teeth. The occurrence and distribution of *acne* on the face, chest, and back; fair or dark *complexion*; presence of palpable *cervical glands*; low or elevated *blood pressure*; character of the *thyroid*, whether normal, slightly enlarged, or presenting adenomatous areas—all appear to be unrelated to the number of damaged teeth. The presence or absence of normal or pathological *tonsils* has no reliable relationship to dental caries. The percentages of persons with 20/20 vision in both *eyes*, of those who wear glasses, of those with hypermetropia or myopia differ but slightly and by amounts which are not statistically significant in the six groups.

The *framework* of the body—as expressed in deviations from a weight standard for age and height, chest capacity, posture, character of the arches of the feet, and the nasal septum—does not show a relationship to dental condition. There is some evidence that tall women are more subject to dental caries than those of medium or short stature. The percentages of those who are over 64 inches in height increase from 29.9 for those who have none to four damaged teeth, to 52.9 for those who have twenty or more. Thirty-one percent of the young women with less than ten damaged teeth are tall, and 36.2 percent with ten or more are tall. Considering the number of persons represented in these two percentages, the standard error of the differences of the percentages is 1.58. Since the differences between the two percentages, 31.7 and 36.2, is 4.5—which is greater than twice, although less than three times, the standard error—the chance that there is a reliable relationship between tallness and dental caries is good. Assuming, then, that tall young women have more damaged teeth than those of moderate or short stature, a possible explanation may be found in (1) racial differences—this is improbable, however, since blondes, demi-blondes, and brunettes, do not differ in their susceptibility to dental caries; (2) the increased demand for skeletal and dental building materials in the period of rapid and excessive growth;

(3) the relationship between age-and-height and age-and-dental-damage within the 15-to-19 age-period. Many students of 15 to 18 years have not attained full stature, nor have they as many damaged teeth as the taller, more mature students of 18 and 19 years. In these, both the number of cavities and stature might be expected to increase with age, and thus lessen or nullify the already uncertain statistical basis for assuming a relationship between stature and dental decay.

Summary. 1. The teeth of 11,117 women students of the University of California, from 15 to 19 years of age, were studied in relation to past illnesses, menstrual experiences, and physical measurements.

2. No thoroughly reliable relationship has been found between the number of damaged teeth and histories of illness, menstrual function, or physical measurements.

Conclusion. This study adds weight to the argument that dental caries is of local or oral, rather than of general bodily significance.

BIOCHEMICAL STUDIES OF AQUEOUS EXTRACTS OF ENAMEL AND DENTIN IN RELATION TO DENTAL CARIES[1]

MAXWELL KARSHAN, PH.D., RICHARD WEINER, B.S., D.D.S., AND NATHAN STOFSKY, B.S., D.D.S.

Department of Biological Chemistry, College of Physicians and Surgeons and School of Dental and Oral Surgery, Columbia University, New York City

In 1929 Bödecker (1) advanced the theory that odontoblasts select certain constituents from blood plasma of the pulp and transmit them to dentinal fibrils, from which they may pass into and through enamel. He called this material "dental lymph," and believed its composition was dependent upon the character of the blood plasma. A twofold function was ascribed to this "lymph:" (1) its mineral salts neutralized acid responsible for decay; (2) it increased slowly the density of both enamel and dentin by deposition of calcium salts. When the present study was started no method had been devised to isolate "lymph" from teeth for direct analysis, and practically nothing was known of its chemical nature. Since the constituents of such "lymph" would presumably be soluble in water, its nature might be disclosed through chemical analyses of aqueous extracts of enamel and dentin. Accordingly, these tissues were shaken in water and determinations made, in the aqueous extracts, for H-ion concentration, calcium, magnesium, sodium, inorganic phosphorus, carbon dioxide (from carbonate, or bicarbonate, or both), chloride, and protein. Comparative tests were also made, for most of these constituents, on enamel and dentin from teeth free from or affected by caries.

METHODS. *Enamel was prepared* by methods described by Rosebury (2) in connection with studies of enamel keratin; freedom from dentin

[1] Conducted with the aid of a grant from the Commonwealth Fund for research in dental caries. Presented at a meeting of the New York Section of the International Association for Dental Research, June 7, 1934. Preliminary reports of portions of this work were included in the proceedings of general meetings of the International Association for Dental Research: (1) Karshan, M., *J. Den. Res.*, 1932, *12*, 523; (2) Karshan, M., Weiner, R., and Stofsky N.: *Ibid.*, 1933, *13*, 238.

was determined by decalcification of some of the material in a collodion bag and microscopic examination of the residue. Dentin was prepared free from enamel, cementum, and pulp tissue by use of disks and burs in a dental engine. All preparations of enamel and dentin were powdered to pass through an 80-mesh sieve before making extractions. The analytical procedures employed are indicated below:

pH: colorimetric method. Phosphate-buffer standards were used with phenol red and brom-thymol blue as indicators.

Calcium was determined by adaptation of a method used on ashed saliva (3): 5 cc. of extract in a 15-cc. centrifuge tube were adjusted to a pH close to 5.9, with 0.1 cc. of 0.04 percent brom-cresol purple as indicator, by addition of 0.0025 *N* and 0.0005 *N* HCl, and 0.15 *N*, 0.015 *N*, and 0.0015 *N* NH_4OH, until lavender-gray was obtained; 2 cc. of 4 percent ammonium oxalate solution having a pH close to 5.9 were added, and the mixture was allowed to stand overnight. After centrifuging, precipitate and tube were washed twice with 0.5 cc. of acetone and 3 cc. of NH_4OH (2 cc. of concentrated NH_4OH to 98 cc. of H_2O). The precipitate was dissolved in 1 cc. of 1 *N* H_2SO_4 and titrated with 0.0025 *N* $KMnO_4$.

Magnesium was precipitated, in 30-cc. centrifuge tubes, as magnesium ammonium phosphate, in the supernatant fluid from the calcium precipitation, by the method of Kramer and Howland (4)—all reagents were reduced to half the volume recommended. After washing with NH_4OH, as described by these authors, the precipitate was dissolved in 1.5 cc. of 20 percent trichloracetic acid, and P determined by Tisdall's method (5). The Mg equivalent was calculated from the P.

Sodium: procedure of Salit (6).

Inorganic phosphorus: Tisdall's method for inorganic phosphates in blood, adapted to the extracts, 4 cc. of which were used.

Carbon-dioxide content. Van Slyke and Neill (7): 5 cc. of extract was run under a layer of CO_2-free water. After delivery of the sample, followed by the water layer, CO_2 was liberated by 0.4 cc. of CO_2-free 1 *N* lactic acid. After making pressure reading, CO_2 was absorbed by 0.4 cc. of 5 *N* NaOH. Calculations were made with factors given by Van Slyke and Sendroy (8).

Chloride. To 2 cc. of extract were added 1 cc. of 20 percent HNO_3 and 1 cc. of 3 percent $AgNO_3$. The ensuing turbidity was compared

with a series of tubes holding 0.05 to 0.7 cc. (intervals of 0.05 cc.) of standard solution containing 0.127 mg. of NaCl per cc., water having been added to make the volume 2 cc. in each, and reagents having been added in the proportions used in the extracts.

EXPERIMENTAL. *pH, Ca, Mg, P, and CO_2-yielding material in enamel and dentin extracts.* Enamel and dentin, in 200-mgm. portions, were added to 10 cc. of water which had been boiled, cooled under paraffin oil, and then adjusted to a pH of 7.0 with brom-thymol blue as indicator. The mixtures were shaken mechanically for one hour (shaking for three hours did not give increased values) and transferred to 15-cc. centrifuge tubes containing about 1 cc. of paraffin oil. After centrifuging, pH and CO_2-content were determined. Other 200-mgm. portions were treated similarly, excepting that they were centrifuged without oil, and their contents of Ca, Mg, and inorganic P determined.

The pH, Ca, P, CO_2 values for enamel and dentin, and the Mg value for dentin—all maximal in initial extracts—were reduced in successive extracts, usually falling to constant levels beginning with the fifth. Although the Mg content of enamel extracts was too small for accurate determination, it appeared to remain fairly constant in successive extracts. These facts indicate that enamel and dentin contained material which was removed by successive extractions; also that the slightly soluble apatite-salts constituting the major portion of enamel and dentin passed into solution in constant amounts, and alone persisted in the last successive extracts (*table 1*).

In the first extracts, the relative amounts of constituents varied greatly from those for whole enamel and dentin. The ratio of P and CO_2-yielding substances to Ca and Mg was much greater in the extracts than in whole enamel or dentin. In later successive extracts of enamel, Ca and P occurred in a ratio close to that in whole enamel; in dentin extracts this ratio approached that in whole dentin. There was thus an excess of P and CO_2-yielding material, in the first extracts, over the amount accountable by combination with Ca and Mg. That this excess of P (as phosphate) and CO_2 (as carbonate or bicarbonate) may occur in soluble form in the teeth as alkali salts, possibly constituting the buffers of "dental lymph," is suggested by the fact that Na is present in both enamel and dentin extracts, as will be indicated later.

Following this series of experiments, 200, 500, and 1000 mgm.-por-

tions of powdered enamel and dentin were each shaken with 25 cc. of adjusted water for one hour, and determinations made for pH, and Ca, Mg, P, and CO_2 contents. Typical results are presented in *table 2*.

TABLE 1

pH, Ca, Mg, P, and CO_2 per 100 cc. of various extracts; with percentage of these constituents in whole enamel and dentin[1]

EXTRACT	pH	Ca	Mg	P	CO_2
		mgm.	*mgm.*	*mgm.*	*mgm.*
Enamel					
First	7.55	0.53	Approximately	0.78	0.91
Second	7.40	0.41	0.1 in all ex-	0.45	0.46
Seventh	7.10	0.25	tracts	0.16	0.17
Dentin					
First	7.90	0.73	0.56	1.31	4.44
Second	7.75	0.47	0.52	0.63	1.73
Seventh	7.40	0.39	0.39	0.35	0.71
Whole enamel[2]		35.7	0.27	17.4	2.97
Whole dentin[2]		24.8	0.79	12.3	3.06

[1] Divide these figures by 20 to convert mgm. per 100 cc. of extract into percentage removed from enamel and dentin.

[2] Ca, Mg, and P in whole enamel and dentin were determined by the method of Kramer and Howland (4); CO_2, by the procedure of Shear and Kramer (14).

TABLE 2

pH, Ca, Mg, P, and CO_2 per 100 cc. of first extract prepared by shaking 200, 500 and 1000 mgm.-portions of enamel and dentin with 25 cc. of water

TISSUE	pH	Ca	Mg	P	CO_2
		mgm.	*mgm.*	*mgm.*	*mgm.*
Enamel (mgm.):					
200	7.47	0.36	...	0.40	0.39
500	7.55	0.46	...	0.72	0.78
1000	7.60	0.58	...	1.18	1.22
Dentin (mgm.):					
200	7.75	0.55	0.45	0.81	2.05
500	7.80	0.64	0.66	1.54	4.20
1000	7.85	0.81	0.89	1.89	6.91

With increased quantities of enamel and dentin there were increases in pH, and in Ca, Mg, and CO_2 contents. If the extracts had contained only material derived from solution of apatite salts, there would have been no such increase, since successive extractions of all of the

samples gave terminal values which were nearly identical. This result is a further indication that water removed substances which occur in small amounts in both enamel and dentin.

A clear crystalline sample of fluorapatite of high purity, and a sample of dahlite (carbonate apatite) in rock, were subjected to tests similar to those on enamel and dentin. Apatite salts of these types are undoubtedly present in enamel and dentin. Successive extracts were made of 500-mgm. portions of powdered material in 25 cc. of water. The results for all extracts were practically the same, Ca and P values being approximately 0.2 mgm. and 0.06 mgm. per 100 cc., respectively. In a test, repeated on a 1000-mgm. portion of impure dahlite, Ca and P values were approximately 0.18 mgm. and 0.12 mgm.

TABLE 3

Average amounts of Na and Cl per 100 cc. of extracts prepared by shaking 200 and 500 mgm.-portions of enamel and dentin with 10 cc. of water

TISSUE	Na				Cl		
	Successive extracts				Successive extracts		
	1st	2nd	3rd	4th	1st	2nd	3rd
	mgm.	*mgm.*	*mgm.*	*mgm.*	*mgm.*	*mgm.*	*mgm.*
Enamel:							
200 mgm.	0.73	0.29	0.25	neg.	0.16	neg.	neg.
500 mgm.	1.48	0.63	0.38	neg.	0.36	neg.	neg.
Dentin:							
200 mgm.	2.55	0.75	0.39	0.30	0.91	neg.	neg.
500 mgm.	5.96	2.19	0.86	0.50	1.80	0.1	neg.

per 100 cc., respectively. These results indicate that hydrolysis was not a significant factor in producing the values obtained for enamel and dentin.

Na and Cl in enamel and dentin extracts. The relative excess of phosphate and of substances yielding CO_2 in the first enamel and dentin extracts, as indicated above, suggested that these may be present in enamel and dentin extracts as alkali salts. Tests were therefore made for Na and K. Presence of K could not be demonstrated; Na, however, was identified and determined quantitatively. For this purpose the extracts were prepared by shaking 200 and 500 mgm.-portions of powdered enamel and dentin with 10 cc. of water for one hour. Na content (*table 3*), maximum in the first extract, decreased succes-

sively until, in the fourth, no more Na could be removed from enamel; the amount obtained from dentin was reduced to a very small fraction of the original value. Cl was found in both enamel and dentin extracts, but the amounts were distinctly less than those required to account for all the Na as chloride. Sulfate could not be detected. The evidence thus warrants the assumption that excess of Na was associated with excess of phosphate and carbonate or bicarbonate in the first extracts.

Does enamel contain soluble protein? The presence of organic matrix in enamel was demonstrated by Bödecker (10, 11) in 1905 and 1906. Later Gies (12) showed that this matrix is protein material. Rosebury (2), who identified this protein as keratin, was unable, with the biuret test, to demonstrate presence of soluble protein in enamel, although the same test showed its presence in dentin. In the present study, extracts prepared by shaking 500 mgm. of powdered enamel with 12 cc. of water for one hour likewise failed to give biuret reactions. Experiments were then performed on enamel extracts with the phenol reagent of Folin and Ciocalteu (13), as used by Greenberg (9) for colorimetric determination of serum proteins. The test was carried out as follows: the enamel-water mixture was centrifuged and 4.5 cc. of extract were treated with 0.2 cc. of 5 *N* NaOH and 0.3 cc. of the phenol reagent. After standing 10 minutes, the ensuing color was compared with a series of tubes containing from 0.05 cc. to 0.1 cc. (intervals of 0.01 cc.) of a standard solution containing 0.02 mgm. of tyrosine per cc. The NaOH and phenol reagent were added to these standard solutions after each had been brought with water to a total volume of 5 cc. The enamel extract yielded a very light blue comparable approximately to that given by solution containing 0.0015 mgm. of tyrosine (in 5 cc.). The same result was obtained with extracts filtered through a Berkfeld "W" candle after being centrifuged. The second extract gave a fainter color; no observable color was obtained in the third and succeeding extracts. From the tyrosine equivalent of the first extract it may be estimated, according to the calculation employed by Greenberg for serum proteins, that approximately 0.01 percent of protein was removed from the enamel. This would be equivalent to the presence of approximately 0.001 cc. of "lymph" in 500 mgm. of enamel. (Blood plasma contains an average of

about 7 grams of protein per 100 cc.) Furthermore, it was found that a solution of albumin (prepared with egg albumin, Merck) having a tyrosine equivalent of the enamel extract failed to give a positive biuret reaction. This observation might explain the failure to obtain a biuret response in enamel extract even if a trace of soluble protein were present. This test, however, is not specific for protein, since a positive reaction is given by free tyrosine and tryptophane, by uric acid, and by phenols in general. It is uncertain, therefore, whether the positive reaction was due to soluble protein or to something else removed from the enamel.

Experiments similar to those described for enamel were performed on horn shavings.[2] Of this material 500 mgm. were shaken with 12 cc. of water, and tests made similar to those on enamel extract. A strong reaction was obtained with the phenol reagent, whereas the biuret response was barely perceptible. Since an albumin solution having a tyrosine equivalent of the horn-shaving extract gives a strong biuret reaction, it is evident that the response with the phenol reagent in the extract from horn shavings was due mainly to substances other than soluble protein. It is conceivable that the positive reaction with the phenol reagent in enamel extract was due to the same or similar causes of the strong positive response in the horn-shaving extract. This is particularly plausible in view of the fact that both enamel and horn are analogous in embryonic origin.[3]

Protein in dentin extracts. Powdered dentin was subjected to tests similar to those performed on enamel. Extracts, prepared by shaking 500 mgm. of material in 12 cc. of water for one hour, yielded positive biuret reactions, in confirmation of Rosebury's finding (2). The protein content was estimated by adding 0.2 cc. of 5 *N* NaOH and 0.3 cc. of phenol reagent to 4.5 cc. of extract obtained by centrifuging dentin-water mixture. The ensuing color was compared with solutions containing 0.5 cc. and 1.5 cc. of the standard used in the enamel tests, made up as before to a total volume of 5 cc. Assuming that the color was due entirely to soluble protein, an estimated average of 0.3 per-

[2] In a discussion with Prof. Wm. J. Gies of the significance of the above findings, it was suggested that parallel tests be made with another ectodermal tissue.

[3] A further study of this phase of the problem will not be undertaken by the authors, but will be continued by Prof. Gies.

cent of protein was removed in the first extract, which was reduced, in the second and third extracts, to 0.065 percent and 0.02 percent, respectively.

Comparative analyses of extracts of enamel and dentin from carious teeth and non-carious teeth.[4] pH, and Ca, P, and CO_2 contents, were determined in both enamel and dentin extracts; Mg was determined, in addition, in dentin extracts. This was carried out by shaking 200 mgm.-portions of material, prepared from individual teeth, for one hour with 10 cc. of water which had been boiled, cooled under paraffin oil, and adjusted to pH 7.0, as in previous tests. After centrifugation under oil, pH, and Ca or P or CO_2 content, were determined. In dentin extracts, Mg was determined in supernatant fluid after precipitating Ca. In some instances composite samples were used. In these cases 500 mgm.-portions were shaken with 25 cc. of water, and all determinations made on the same extract. The results are summarized in *table 4*. Slight differences were obtained in average values for enamel and dentin of non-carious and carious teeth, but the distribution of individual values is such that no definite trend is indicated. Therefore the observed differences may be assumed to be without significance.

We conducted, in addition, comparative protein analyses in extracts of dentin from 9 non-carious and 18 carious teeth. The phenol reagent was used as previously described. In all calculations the working assumption was made that the ensuing color was due entirely to soluble protein. The extracts were prepared by shaking 250 mgm. of dentin in 6 cc. of water for one hour, followed by centrifugation. The average percentage amount of protein removed in the first extract was 0.37 ± 0.07 for non-carious dentin; 0.27 ± 0.05, for carious. This was reduced, in the second extract, to an average of 0.068 ± 0.014 percent for the former; 0.063 ± 0.012 percent, for the latter. Because of the limited number of determinations, it is uncertain whether the observed difference is significant.

SUMMARY. Aqueous extracts of 200 mgm.-portions of powdered enamel and dentin, in 10 cc. of water adjusted to pH 7.0, had average

[4] The enamel and dentin from carious teeth were taken from regions that had not been visibly affected. All discolored, softened, or decayed areas were avoided.

pH values of 7.55 for enamel and 7.85 for dentin. These extracts contained Ca, Mg, P, and CO_2- yielding material.

Ca, P, and CO_2-yielding material were dissolved in successive extracts of enamel and dentin. Small amounts of Mg were also removed. A constant level was reached beginning with about the fifth extract, after which only the slightly soluble apatite salts passed into solution.

A consideration of the relative amounts of these constituents, in the

TABLE 4

Comparison of average values and average deviations of pH, Ca, Mg, P, and CO_2, in aqueous extracts of non-carious and carious enamel and dentin[1]

CONSTITUENT	TOOTH CONDITION	ENAMEL				DENTIN			
		Total samples	Individual analyses	Composite analyses	Values and deviations	Total samples	Individual analyses	Composite analyses	Values and deviations
pH	Non-car.	65	42	5	7.58 ±0.06	48	34	5	7.85 ±0.07
	Car.	68	48	5	7.53 ±0.07	59	54	5	7.85 ±0.06
Ca	Non-car.	28	14	3	0.51 ±0.07	24	15	3	0.58 ±0.05
	Car.	26	14	3	0.54 ±0.07	27	18	3	0.59 ±0.06
P	Non-car.	39	16	5	0.71 ±0.06	31	17	5	1.35 ±0.15
	Car.	36	16	5	0.73 ±0.07	40	28	5	1.32 ±0.14
CO_2	Non-car.	34	15	4	1.00 ±0.13	27	13	5	4.71 ±0.62
	Car.	37	17	5	1.00 ±0.15	24	19	5	4.67 ±0.46
Mg	Non-car.	..	..	..	...	17	3	5	0.60 ±0.10
	Car.	..	..	..	...	21	9	5	0.64 ±0.11

[1] Figures for Ca, Mg, P, and CO_2 represent mgm. per 100 cc. of *first* extracts.

tissues and extracts, indicates that the extracts contained excesses of P and CO_2-yielding material over the amounts accountable by combination with Ca and Mg. The fact that Na was present in both enamel and dentin extracts in excess of chlorides suggests that the excesses of P (as phosphate) and CO_2 (as carbonate or bicarbonate) occur as alkali salts in these tissues, possibly constituting the buffers of "dental lymph."

Comparative determinations of pH, and Ca, P, and CO_2 contents, in

extracts of enamel and dentin from *non-carious* and *carious* teeth—and of Mg in dentin extracts—gave no significant differences.

Aqueous extracts of powdered enamel yielded positive responses with the phenol reagent of Folin and Ciocalteu, although the biuret reaction was negative. The phenol reagent reacts with proteins containing tyrosine and tryptophane, but gives positive reactions also with free tyrosine, tryptophane, uric acid, and phenols in general. Whether enamel contains soluble protein remains uncertain.

Aqueous extracts of powdered dentin responded positively to the biuret reaction. Estimations with the phenol reagent indicated that 0.3 percent and 0.065 percent of protein were removed in the first and second extracts, respectively. On the basis of a short series of determinations, the average values for protein extracted from dentin was greater for non-carious teeth than for carious ones. The calculations were based on the working assumption that the reaction with the phenol reagent was due entirely to soluble protein.

REFERENCES TO LITERATURE

(1) Bödecker, C. F. 1929 *Dental Cosmos, 71,* 586.
(2) Rosebury, T. 1930 *Journal of Dental Research, 10,* 187.
(3) Krasnow, F., Karshan, M., and Krejci, L. E. 1932 *Journal of Laboratory and Clinical Medicine, 17,* 1148.
(4) Kramer, B., and Howland, J. 1926 *Journal of Biological Chemistry,* 68, 711.
(5) Tisdall, F. F. 1922 *Ibid., 50,* 329.
(6) Salit, P. W. 1932 *Ibid., 96,* 659.
(7) Van Slyke, D. D., and Neill, J. M. 1924 *Ibid., 61,* 523.
(8) Van Slyke, D. D., and Sendroy, J. 1927 *Ibid., 73,* 121.
(9) Greenberg, D. M. 1929 *Ibid., 82,* 545.
(10) Bödecker, C. F. 1905 *Dental Review, 19,* 448.
(11) Bödecker, C. F. 1906 *Ibid., 20,* 317.
(12) Gies, W. J. 1926 *Journal of Dental Research, 6,* 143.
(13) Folin, O., and Ciocalteu, V. 1927 *Journal of Biological Chemistry, 73,* 627.
(14) Shear, M. J., and Kramer, B. 1928 *Ibid., 79,* 105.

SOLUTION RATE OF APATITE IN AN AVERAGE MOUTH[1]

PETER J. BREKHUS, B.A., D.D.S., F.A.C.D., AND W. D. ARMSTRONG, PH.D.

School of Dentistry, and Laboratory of Physiological Chemistry, University of Minnesota, Minneapolis, Minn.

The x-ray spectrographic work of de Jong, Taylor and Sheard, and Mrs. Clark, has demonstrated the probability that the inorganic phase of bones and teeth is apatite. Apatites are isomorphous minerals of wide occurrence, which may be described as double salts of Ca and hypothetical tricalcium phosphate. Their composition may be represented by the formula $[CaX \cdot Ca_3(PO_4)_2]_3$, where X is CO_3, $(OH)_2$, F_2, Cl_2, etc. Chemical analysis of bone, however, requires that the formula indicate a varying ratio in respect to CaX and $Ca_3(PO_4)_2$ in the materials. Accordingly, Roseberry, Hastings, and Morse represent the approximate composition of the mineral material of bone by the formula $[CaX \cdot Ca_3(PO_4)_2]_n$, where n is either 2 or 3, but usually nearer 2 than 3. McClendon and his co-workers have determined that no solution of apatite occurred in artificial salivas at or above pH 5.5. Thus the insolubility of apatite is compatible with the evidence that the inorganic material of enamel is apatite.

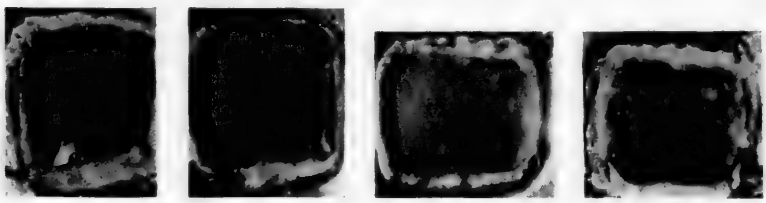
The fact that the upper left first molar of one of us (W. D. A.) had been extracted allowed us to determine the solution tendency of apatite in saliva under the conditions in an average mouth. A Nesbit-type removable-bridge was so cast that square holes 3 mm. deep and 3 mm. square were produced on the lingual and buccal sides of the appliance. Into these holes cubical pieces of apatite were sealed with gutta-percha in such a manner that the exposed surface of the mineral was flush with the medial and lateral surfaces of the bridge. The pieces of apatite were carefully cleaned and weighed on a micro-balance before they were sealed in place, and photographs of the surfaces of the test-pieces were made at the beginning of the experiment. The

[1] Presented at the twelfth general meeting of the International Association for Dental Research, Chicago, March 17 and 18, 1934; *J. Den. Res.*, 1934, *14*, 165.

teeth were cleaned and all carious lesions filled at the start of the experiment.

The specimen in the lingual side came from Japan; that on the buccal side (from Durango, Mexico) was obtained from the Smithsonian Institution through the courtesy of Dr. William F. Foshag.

The bridge and pieces of retained apatite were carried continuously in the mouth for one year. The pieces of apatite received the same treatment as to brushing with a tooth paste, etc., as did the teeth in the mouth. At the end of the year, the surfaces of the apatite pieces



1 2 3 4

FIGS. 1 and 2. *Buccal* apatite inset: before (1), and at end of (2), one year's carriage in mouth

FIGS. 3 and 4. *Lingual* apatite inset: before (3), and at end of (4), one year's carriage in mouth

were rephotographed and reweighed, with the following numerical results (see also *figs. 1–4*):

	Original weight *mgms.*	Weight loss in one year *mgms.*	Percentage loss
Lingual piece.....	48.055	0.034	0.07
Buccal piece.....	39.597	0.052	0.13

Very probably the recorded losses in weight are within the limits of error of the experiment, but they indicate that the rate of solution of apatite in an average mouth is low enough to be compatible with the evidence that the inorganic phase of enamel is apatite.

LITERATURE CITED

(1) CLARK, JANET: *Am. Jour. Physiol.*, *98*, 328 (1931).
(2) DE JONG, W. F.: *Rec. trav. chim. Pays-Bos*, *45*, 444 (1926).
(3) MCCLENDON, J. F. *et al.*: *J. Den. Res.*, *3*, 50 (1921).
(4) ROSEBERRY, H. H., HASTINGS, A. B., AND MORSE, J. K.: *J. Biol. Chem.*, *90*, 359 (1931).
(5) TAYLOR, N. W., AND SHEARD, C.: *Ibid.*, *81*, 479 (1929).

A NON-TORQUE CLASP[1]

ARTHUR B. GABEL, M.A., D.D.S.

School of Dentistry, University of Pennsylvania, Philadelphia, Pa.

The writer has designed a clasp which, in combination tooth-and-tissue-bearing restorations—tooth supported at one end only—will transfer part of the stress of mastication to the supporting tooth in such a manner as to produce no torque. In the conventional clasp, torque is produced as a result of two more or less independent factors. The first is the fact that the point of contact of the occlusal rest of the clasp with the tooth is on the margin of the occlusal surface of the tooth rather than at the point of intersection of the long axis of the tooth with this surface. The second is the fact that the saddle, being tooth-supported at one end, cannot move parallel to itself when the soft tissue is compressed or resorption of the alveolar bone takes place. The supporting tooth, being more or less rigidly held by the clasp, is thus subjected to a torque in the mesio-distal plane which, in a comparatively short time, causes disease of its investing tissues.

The non-torque clasp is designed so that the normal occlusal stress is transmitted to the tooth in the bucco-lingual plane through the long axis of the tooth. The saddle is connected with the clasp through a hinge-joint, which permits its rotation about an axis perpendicular to the mesio-distal plane. This axis also intersects the long axis of the tooth. The two adverse factors inherent in the conventional clasp are thus entirely obviated. The clasp itself is of the basket- or crib-type, with mesial and distal occlusal rests. For a rotated tooth, care must be taken to place these rests diametrically opposite each other. The axis of the hinge consists of short pins cast into the clasp buccally and lingually as near the mesio-distal center of the tooth as possible. It is essential (1) that the pins, also, be diametrically opposite each other and in the same straight line, which must pass through the axis

[1] The cost of the illustrations has been met from a grant, to the *Journal*, by the Academy of Stomatology of Philadelphia. The Academy's generous support is appreciated by the author and by the editors.—[*Ed.*]

of the tooth, and (2) that this line be perpendicular to the plane in which the saddle moves owing to tissue compression.

In *fig. 1*, *BuLi*, and *MD* need not be at right angles (though the construction is somewhat improved if they are), but they should intersect on the long axis of the tooth represented by *O*. When this condition obtains, the resultant of the occlusal stresses transmitted through the saddle to the clasp pass along the long axis of the tooth. In order to prevent the saddle from rotating about the long axis of the tooth as an axis, or about an axis parallel to the ridge, it is constrained to move in one plane by a stabilizer consisting of the flattened extension

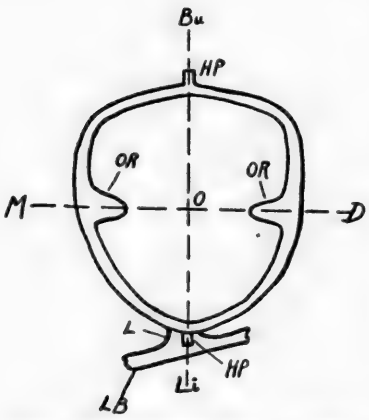


FIG. 1. Occlusal view of clasp. *Bu*, buccal; *Li*, lingual; *OR*, occlusal rest; *HP*, hinge pin; *L*, lug; *LB*, lingual bar

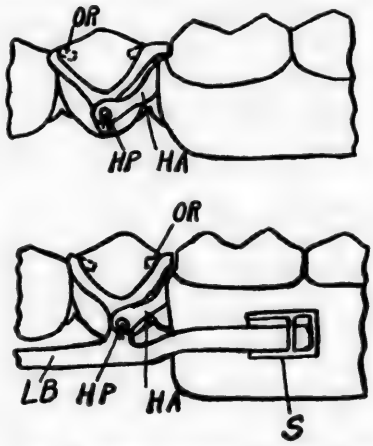


FIG. 2. Top: buccal view. Bottom: lingual view: *OR*, occlusal rest; *HP*, hinge pin; *HA*, hinge arm; *LB*, lingual bar; *S*, stabilizer.

of the lingual (in the mandibular case) bar held in a shallow box imbedded in the lingual surface of the saddle (*fig. 2*). The bar is rigidly fastened to two clasps and consequently immovable. This construction permits individual and independent saddle-movement in the bilateral case.

The appliance has been designed particularly for mandibular partial dentures, but the same principles may be applied in both jaws with mechanical variations. The development of this project was made possible by a grant from the Special Research Fund of the University of Pennsylvania.

EFFECTS OF SHORT ELECTRIC WAVES UPON STREPTOCOCCI FROM INFECTED TEETH[1]

J. S. OARTEL, D.D.S., M.S., AND E. ALFRED WOLF, PH.D.

School of Dentistry and Department of Zoology, University of Pittsburgh, Pittsburgh, Pa.

I. INTRODUCTION. Specific biological effects of high-frequency fields were first reported in 1893 by d'Arsonval (1). He described the action of such fields upon animals, resulting in elevations of temperature and increased metabolism. d'Arsonval and Charrin (2) reported changes in production of pigment in bacillus pyocyaneus, and also attenuation of diphtheria toxin, by high-frequency currents (3). No further work was done, apparently, until thirty years later, when biological effects of high-frequency oscillations generated by the three-electrode vacuum-tube were first investigated (4). Since that time many research workers have studied effects of such high-frequency fields. Production of artificial fevers (5), attenuation of bacterial toxins (6), treatment of malignant tumors (7), acceleration of plant growth, nervous reactions and tissue regeneration (8), have recently been investigated.

The present study was designed to determine effects of short electric waves upon microörganisms commonly found in dentine of roots of infected teeth. The treatment of the organisms in this experiment was decidedly different from that used by other workers in this field. The organisms were radiated while still n the dentine of the tooth roots—their natural habitat—and were not previously cultured and then radiated while in a liquid culture-medium or upon a solid culture-medium. Considerable heating occurs when liquids or substances containing a high percentage of moisture are placed in the high-frequency field. No heating of any consequence was observed when root fragments were radiated. Dentine contains but 8 percent of water, which is held as water of combination (9). From clinical experience,

[1] Presented at the joint meeting of the American College of Dentists with Section N of the American Association for the Advancement of Science, Boston, December 29, 1933; see abstract, *J. Amer. Col. Den.*, 1934, *1*, 56; April.

we believe the roots of many infected teeth (devitalized ones in particular) contain considerably less moisture than the normal amount.

II. METHODS. *1. Source of cultures.* Teeth, whose pulp chambers had been infected by deep caries, and which had been extracted not more than 24 hours, were used as the source of the bacterial cultures.

2. Preparation of root fragment for radiation. The tooth to be radiated was held in sterile pliers and immersed in alcohol, then flamed, the alcohol igniting; extinguished after one or two seconds, and the alcohol re-ignited; and the process repeated until the alcohol was consumed. Care was taken to prevent the alcohol from burning too long at a time, so that the tooth structure would not become hot enough to destroy organisms within the dentine. The tooth, thus sterilized externally, was then placed between sterile-gauze dressings, and the apical portion of the root crushed with sterile bone-forceps. With sterile pliers, a root fragment was wrapped in sterile gauze and placed at the bottom of a sterile glass-tube having an outside diameter of 1 cm. The mouth of the tube was plugged with sterile cotton. The gauze-wrapping that enclosed the root fragment held it in the same position in the tube at all times.

3. Preparation of control. After the root had been crushed, a fragment that occupied a position immediately adjacent to the fragment chosen for radiation was placed in a sterile tube until the other fragment had been radiated.

4. Radiation of root fragments. The tubes containing the wrapped fragments were placed separately between the condenser plates of the high-frequency apparatus devised by Dr. G. Murray McKinley of Pittsburgh (10), and exposures varying from 5 to 60 minutes were applied. A wave-length of approximately 3.2 meters, with a frequency of 90,000,000 cycles per second and 3.0 to 3.8 amperes, was employed. The distance between the condensor plates was always 1 cm. *Fig. 1* shows a sketch of the high-frequency apparatus; *fig. 2* shows the generating and exposure circuits.

5. Culture of root fragments. Immediately after radiation, all root fragments, radiated and non-radiated, were seeded into tubes of brain-heart infusion, to which brom-cresol-purple had been added. The surface of the medium thus inoculated was covered at once with melted, sterile, white vaseline to a depth of approximately 1 cm.

After the vaseline had congealed, the tube of inoculated medium was incubated at 37°C.

6. Macroscopic examination. When growth occurred, the acid produced by bacterial activity on the sugars of the medium caused the purple indicator to change to bright lemon-yellow. Growth was usually evidenced by cloudiness or turbidity before a color change developed. It was noted, early in the experiment, that the culture

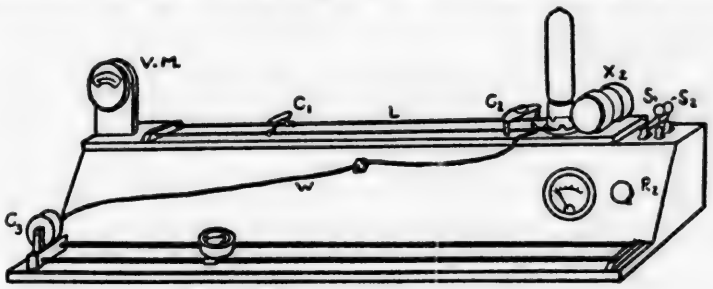


FIG. 1. HIGH-FREQUENCY APPARATUS

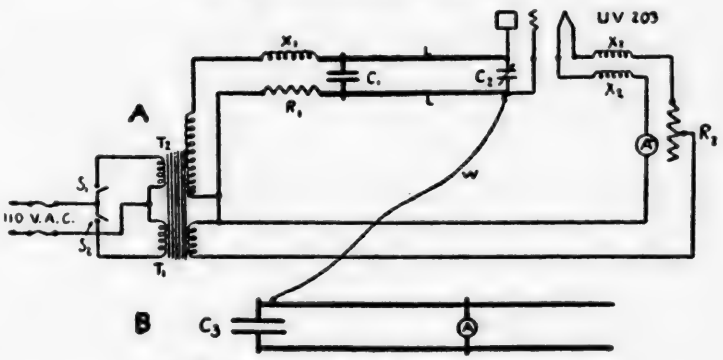


FIG. 2. GENERATING AND EXPOSURE CIRCUITS

tubes containing radiated fragments were considerably slower in showing evidences of growth. In order to secure definite data on this effect, five stages of growth were arbitrarily chosen according to the appearance of the culture medium. The various times at which such stages of growth were reached were carefully noted. The various stages chosen were: (1) no color change, slight turbidity; (2) slight loss of purple, slight turbidity; (3) complete loss of purple, yellow, heavy

turbidity; (4) yellow, turbidity clearing at top of medium; (5) clear yellow, no turbidity, sediment at bottom of tube. *Fig. 3* shows such a series of changes; also non-inoculated medium (0). The numerals correspond to the stages mentioned above. Unfortunately such color changes are not clearly reproduced in an ordinary photograph. Where lethals were produced and no growth occurred, the appearance of the original medium—clear, rich purple—remained unchanged.

7. Microscopic examination. After 48 hours of incubation, the cultures were examined in the following manner: the plug and end of the tube having been flamed, a sterile platinum loop was passed into the tube and the vaseline plug broken in two opposite places at the periphery of the vaseline. The loop was removed and heated to white heat to destroy all traces of vaseline and culture. The tube was slanted at about 45°, which permitted the broth to flow through the lower puncture as air entered the upper one. With a cool, sterile platinum loop some of the culture which flowed through the opening in the vaseline plug was removed and smeared on a clean glass-slide. The slide was then stained with gentian violet and examined under oil as to the character of the organisms. Smears were prepared from the control tube in the same manner. Microscopes having the same optical equipment were placed side by side with the non-radiated specimen—the control under one microscope, the radiated specimen from the same root under the other. The organisms of the two cultures were compared as to morphology, size, and arrangement.

8. Transfer cultures. Transfer cultures were made from a number of tubes to determine whether changes in morphology and size were permanent. These transfers were made in the following manner: the original culture-tubes were treated in the same way as when smears were made, except that the loopful of culture was placed into a tube of sterile culture-medium. The medium was covered with melted vaseline as with the original cultures. Successive cultures were made in the same manner at 48-hour intervals.

III. DISCUSSION. *A. Effects of short electric waves as seen by macroscopic examination. 1. Lethality.* Of the 105 radiated fragments, lethal effect was produced in 28.6 percent, growth having been obtained from the corresponding controls.

2. Retardation of growth. (*a*) *In original cultures.*—In many tubes

in which lethality did not occur there was retardation in the appearance of evidence of bacterial growth, as compared with that in con-

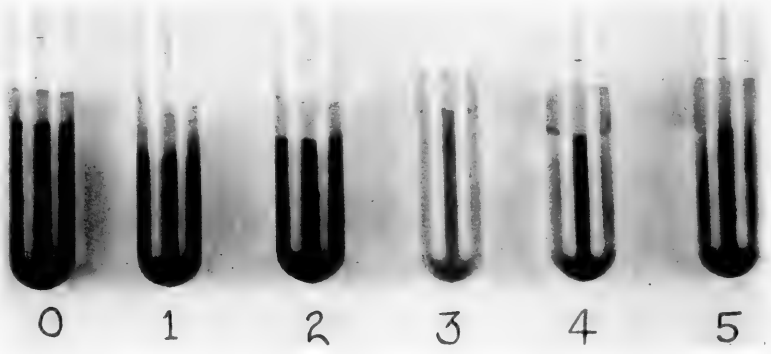


FIG. 3. CULTURE-TUBES SHOWING COMPARATIVE GROWTH-CHANGES

(0) Original non-inoculated medium, clear, rich purple. (1) No color change, slight turbidity. (2) Slight loss of purple, slight turbidity. (3) Complete loss of purple; yellow, heavy turbidity. (4) Yellow, turbidity clearing at top of medium. (5) Clear yellow, no turbidity, sediment at bottom of tube

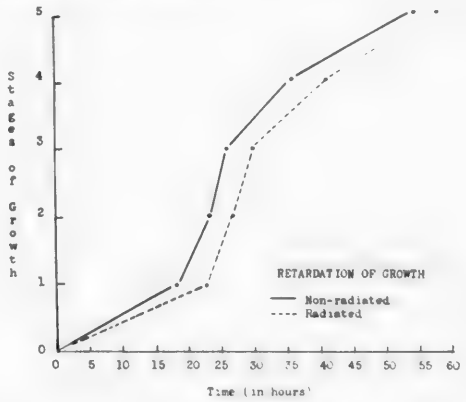


FIG. 4. RETARDATION OF GROWTH; FROM RADIATED SPECIMENS

trols. The time taken for each of eight radiated cultures and eight controls to reach the five stages, mentioned above, was carefully recorded. The varying times for each culture were averaged, and a

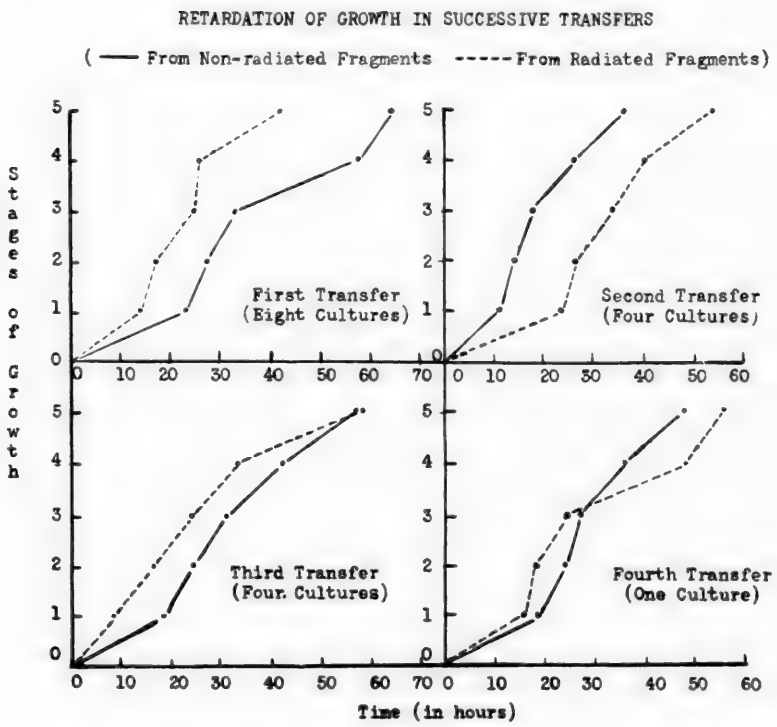
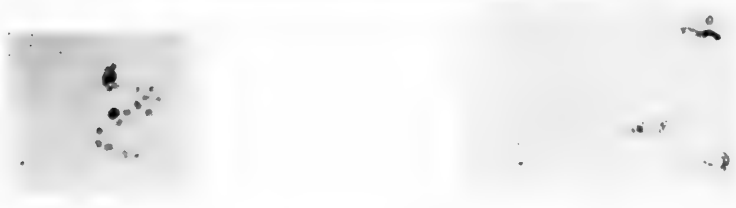

RETARDATION OF GROWTH IN SUCCESSIVE TRANSFERS
(—— From Non-radiated Fragments ----- From Radiated Fragments)
Stages of Growth
First Transfer (Eight Cultures)
Second Transfer (Four Cultures)
Third Transfer (Four. Cultures)
Fourth Transfer (One Culture)
Time (in hours)

FIG. 5. RETARDATION OF GROWTH IN SUCCESSIVE TRANSFERS



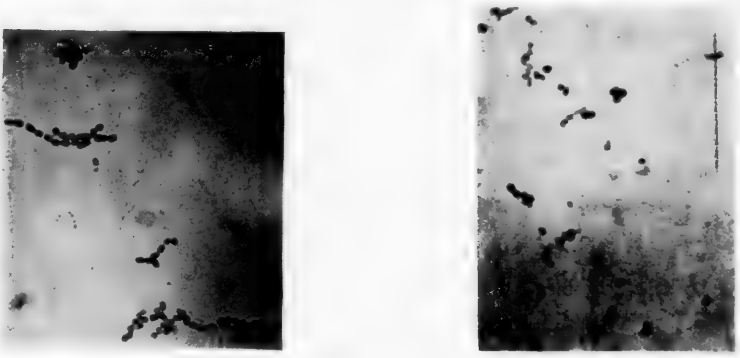
A B

FIG. 6. DIMINUTION IN SIZE OF RADIATED ORGANISM. ×1250
A—Culture 26, non-radiated. B—Culture 26R, radiation time—10 minutes

curve plotted showing the time of growth for the non-radiated and the radiated root-fragments. *Fig. 4* shows graphically the lag period of the radiated specimens. From this graph the average lapse of time

A B

FIG. 7. CHANGE IN GROUPING: CHAINS TO DIPLOCOCCI. ×1250
A—Culture 32, non-radiated. B—Culture 32R, radiation time—30 minutes

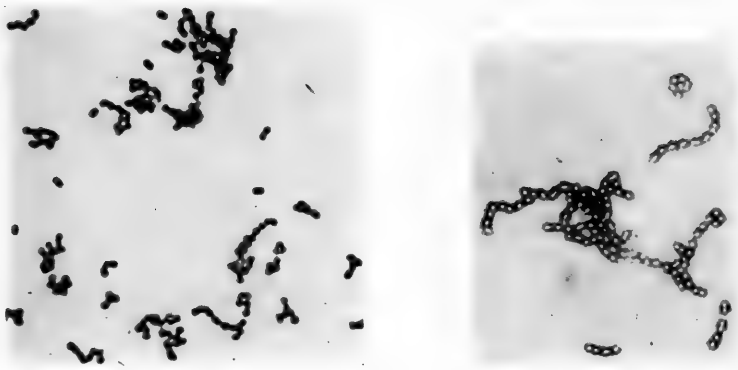


A B

FIG. 8. CHANGE IN GROUPING: LONG TO SHORT CHAINS. ×1250
A—Culture 28, non-radiated. B—Culture 28R, radiation time—15 minutes

A B

FIG. 9. CHANGE IN GROUPING: CLUMPING. ×1250
A—Culture 49, non-radiated. B—Culture 49R, radiation time—45 minutes



A B

FIG. 10. REVERSION; INCREASE IN SIZE. ×1250

A—Culture 110, non-radiated. B—Culture 110R, radiation time—15 minutes

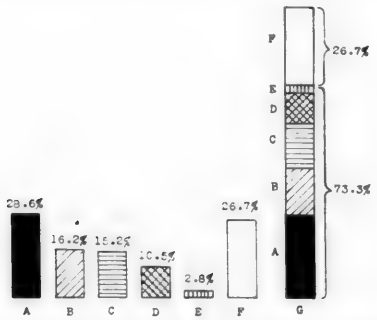


FIG. 11. TOTAL PERCENTAGES OF EFFECTS OF RADIATION

A—Lethals. B—Diminution in size of organism. C—Grouping change. D—Grouping change and diminution of size. E—Increase in size of organism. F—No effect. G—Summary

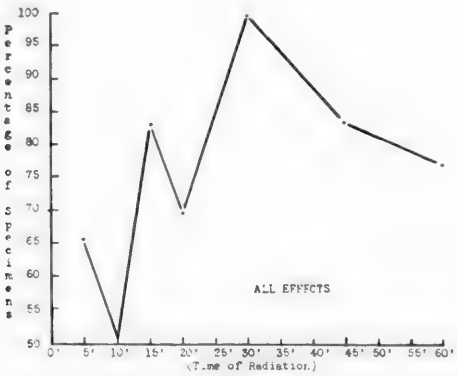


FIG. 12. ALL CHANGES AND LETHALITY GROUPED AND PLOTTED AGAINST LENGTH OF EXPOSURE

between growth from the non-radiated and radiated root-fragments is seen to be 4.5 hours.

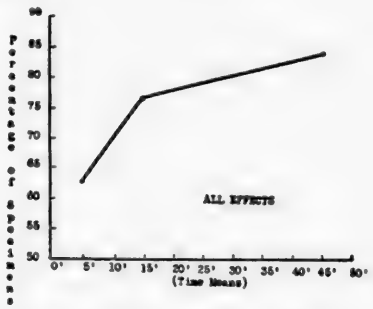


FIG. 13. ALL EFFECTS OF RADIATION CONSIDERED TOGETHER AND LARGER TIME-GROUPINGS PLOTTED

TABLE 1

Summation of all effects (percentages)

MINUTES RADIATED	NUMBER OF SPECIMENS	LETHALS	DIMINUTION OF SIZE	CHANGES IN GROUPING	GROUPING AND DIMINUTION	REVERSION	TOTAL
5	35	37	14	6	6	3	66
10	8	12.5	12.5	12.5	12.5	....	50
15	19	21	21	21	10.5	10.5	84
20	12	8	8	46	8	....	70
30	5	20	....	40	40	....	100
45	13	30	30	8	16	....	84
60	13	47.5	15	7.5	7.5	....	77.5

TABLE 2

Larger time-groupings

MINUTES RADIATED	TIME MEANS	NUMBER OF SPECIMENS	NUMBER SHOWING CHANGES	PERCENTAGE SHOWING CHANGES
0 to 10	5	43	27	63
10 to 20	15	31	24	77
30 to 60	45	31	26	84

(*b*) *Retardation of growth in transfers.*—In a number of successive transfer cultures, the delay of growth was gradually reduced. In the fourth transfer, where growth occurred in only one radiated culture

and its corresponding control, the curves of growth from the radiated and non-radiated fragments were almost identical. *Fig. 5* shows curves plotted from the average time taken by transfer cultures to reach the various stages of growth.

B. Effects of high-frequency radiation as seen by microscopic examination. After 48 hours of incubation, all tubes showing evidence of growth were examined microscopically. In all, the familiar diplostreptococci commonly found in infected teeth were seen, but a considerable number of the organisms showed that the radiation had produced some very striking changes.

1. Cultures showing no effect of radiation. Of radiated root-fragments, 26.7 percent exhibited no apparent effect of radiation.

2. Diminution of size of organisms. In 16.2 percent of the cultures from radiated root-fragments, there was diminution in size of the organisms as compared with those cultured from non-radiated root-fragments. Comparisons were made by observation, without exact measurements. *Fig. 6* presents photomicrographs showing diminution in size.

3. Changes in grouping. A change in the manner of grouping was evident in 15.2 percent of all specimens studied. Of such changes, 87 percent were from chains to diplococci, the remainder being mainly from long- to short-chain streptococci; a few exhibited tendency to clump or group in the manner of staphylococci (*figs. 7, 8,* and *9*).

4. Changes in grouping and diminution in size of organisms. Both changes in grouping and diminution in size of the organisms were evident in 10.5 percent of the cultures from radiated root-fragments.

5. Reversion. In 2.8 percent of the cultures from radiated root-fragments, a reversion or increase in size was noted (*fig. 10*).

6. Organisms in transfer cultures. A study of smears from transfers revealed that diminution in size of radiated organisms was apparently permanent, persisting through four transfers. Forty-eight-hour transfers from original non-radiated culture failed to reveal such diminution of size although carried through three successive transfers. Such diminution in size was observed in cultures from non-radiated sources after 96-hour incubation, owing no doubt to usage of available food in the medium. Long-chain streptococci with very small organ-

isms were seen in the later transfers from both types of cultures, e.g., from radiated and non-radiated root-fragments, which were originally diplo-streptococci in small chains.

C. Summation of all effects. Summarizing the effects for various lengths of exposure, the percentages shown in *table 1* were obtained. *Fig. 11* depicts, in a different manner, total percentages of effects of radiation.

When all changes and lethality were grouped together and plotted against length of exposure, the curve shown in *fig. 12* resulted. Here a very uneven curve is seen at the shorter periods of high-frequency radiation, owing no doubt to the comparatively small number of root-fragments radiated for 10, 20, and 30 minutes. This may also have been influenced by the degree of virulence of the organisms, difference in structure of teeth used, or other biological variants over which one has little control. When, however, all effects of radiation were considered together and larger time-groupings made, the influence of uncontrolled variants was reduced to a minimum. Such a grouping (*table 2*), when plotted (*fig. 13*), produces an exponential curve showing that the relation between length of exposure to the short electric waves and the effect produced is of exponential character.

Studies of this kind cannot be regarded as final, especially with respect to interpretations of results. No virulence determinations, either by animal inoculation or by the electrophoretic method, have been made. Such studies are contemplated, and will add greatly to our valuation of the effects of short electric waves.

IV. SUMMARY. Short electric waves of high frequency induced very decided effects on streptococci as cultured from infected teeth. In 73.3 percent of radiated specimens the effects were as follows: (a) lethal effect in 28.6 percent; (b) diminution in size of organisms in 16.2 percent; (c) changes in manner of grouping of organisms in 15.2 percent; (d) both diminution in size and changes in grouping in 10.5 percent; (e) reversion, or increase in size of organisms, in 2.8 percent; (f) retardation of growth of radiated organisms.

In general, the effects of radiation were found to be of exponential character.

REFERENCES TO LITERATURE

(1) D'ARSONVAL: *Comptes Ren. de la Soc. de Biol.*, Feb. 4, 1893.
(2) D'ARSONVAL AND CHARRIN: *Ibid.*, May 6, 1893; p. 467.
(3) ——: *Ibid.*, Feb. 1, 1896; p. 121.
(4) GOSSET, A., GUTMANN, A., LAKHOWSKY, G., AND MAGROU, I.: Essai de therapeutique du 'cancer experimental' des plantes, *Ibid.*, *91* (1924); p. 626.
(5) CARPENTER, C. M., AND PAGE, A. B.: Production of fever in man by short radio waves, *Science*, *71* (1930); p. 450.
(6) HICKS, R. A., AND SZYMANOWSKI, W. T.: The biologic action of ultra-high frequency currents, *J. Infec. Dis.*, *50* (1932); p. 466.
(7) SCHERESCHEWSKY, J. W.: The action of currents of very high frequency upon tissue cells—upon a transplantable mouse sarcoma, *U. S. Public Health Report*, *43* (1928); p. 927.
(8) MCKINLEY, G. M.: Some biological effects of high frequency electrostatic fields, *Proc. Penna. Acad. Sci.*, *4* (1930).
(9) NOYES, F. B.: *A textbook of dental histology and embryology, 4th ed.;* Lea and Febiger, Philadelphia; 1929.
(10) MCKINLEY, J. G., JR., AND MCKINLEY, G. M.: High frequency equipment for biological experimentation, *Science*, *71* (1930); p. 508.

SUPPLEMENT

CONTENTS

I. International Association for Dental Research. Register of members by sections: December 1, 1934.[1] Compiled by the *General Secretary* 471
II. Note on the William J. Gies Fellowship in Biological Chemistry at Columbia University. *Edgar G. Miller, Jr.*, Ph.D., Chairman of the Fellowship Committee 474
III. Quotations: dental journalism 475
IV. Correction: *Frances Krasnow*, M.A., Ph.D. 480

I. INTERNATIONAL ASSOCIATION FOR DENTAL RESEARCH

REGISTER OF MEMBERS BY SECTIONS:[2] DECEMBER 1, 1934

Compiled by the General Secretary

1. *Ann Arbor Section.*—R. K. Brown, R. W. Bunting, C. M. Dixon, J. O. Goodsell, Faith P. Hadley, Philip Jay, R. H. Kingery, C. J. Lyons, G. R. Moore, **U. G. Rickert*, E. O. Scott, F. B. Vedder, M. L. Ward.—13

2. *Baltimore Section.*—**M. S. Aisenberg*, G. M. Anderson, E. C. Dobbs, Harold Goldstein, E. V. McCollum, J. B. Robinson, A. H. Schultz.—7

3. *Boston Section.*—L. W. Baker, F. R. Blumenthal, P. E. Boyle, W. G. Bridge, F. P. Chillingworth, F. H. Cushman, **F. H. Daley*, C. E. Hatch, J. C. Healy, E. A. Hooton, P. R. Howe, V. H. Kazanjian, P. A. Leavitt, F. P. McCarthy, L. M. S. Miner, A. L. Morse, F. W. Morse, R. J. Nagle, S. E. Pond, A. P. Rogers, Benjamin Spector, K. H. Thoma, Benjamin Tishler, Harry Trimble, G. H. Wright.—25

* Secretary of the Section.

[1] Data of the executive proceedings at the twelfth general meeting, in Chicago, Ill., March 17 and 18, 1934, were published on pages 237–241 of the *J. Den. Res.* for June 1934.

[2] During 1933–34 meetings of sections were held on this schedule: *Ann Arbor*—May 8. *Baltimore*—Oct. 24, Nov. 15, Jan. 31. *Boston*—Nov. 6, Jan. 29, May 21. *Chicago*—Oct. 27, Jan. 26, May 18. *Cleveland*—Feb. 12. *Columbus*—Mar. 9. *Halifax*—Nov. 19, Jan. 25, Mar. 14. *London*—Oct. 18, Dec. 6, Jan. 24, Apr. 18. *Louisville*—May 11. *Minnesota*—Nov. 20, Jan. 22, Feb. 26. *New York*—Dec. 7, June 7. *Philadelphia*—Oct. 13. *Pittsburgh*—Oct. 2, Nov. 6, Dec. 4, Jan. 8, Mar. 19, May 7. *Prague*—Jan. 12, May ?. *Richmond*—Nov. 18, Apr. 18, May 26. *Rochester*—Oct. 13, 27; Nov. 10, 24; Dec. 8, 22; Jan. 5, 19; Feb. 2, 16; Mar. 2, 16; Apr. 13, 27; May 11, 25. *St. Louis*—Nov. 14, Jan. 9, Apr. 10. *San Francisco*—Nov. 16, Jan. 24, Feb. 28, Mar. 28, Apr. 25. *Toronto*—July 17, Sept. 12, Oct. 20, Jan. 18. *Washington*—May 3. *Winnipeg*—Feb. 7, May 28.

4. *Budapest Section.*—Károlyi Balogh, István Bánhegyi, Béla Bonyhárd, János Brand, Béla De Simon, Károly Ferenczy, Elek Földi, Dezsö Hattyasy, Oszkár Kaufmann, **Ferenc Köszeg*, Ervin Landgraf, Gusztáv Morelli, Rudolf Rehák, Henrik Salamon, László Sugár, József Szabó, Steven Varga, Dénes von Máthé.—18

5. *Chengtu Section.*—Mary C. Agnew (Mrs. R. G.), **R. G. Agnew*, H. B. Collier, L. G. Kilborn, A. W. Lindsay.—5

6. *Chicago Section.*—Olaf Bergeim, A. D. Black, **J. R. Blayney*, E. P. Boulger, A. G. Brodie, E. D. Coolidge, W. G. Downs, Jr., E. B. Fink, C. W. Freeman, S. M. Gordon, E. H. Hatton, R. G. Kesel, Rudolf Kronfeld, W. H. G. Logan, A. H. Mueller, Emil Mueller, Anna C. Nichols, F. B. Noyes, H. J. Noyes, V. T. Nylander, E. C. Pendleton, H. A. Potts, Isaac Schour, B. O. Sippy, W. G. Skillen, E. W. Skinner, S. D. Tylman, W. H. Welker, Warren Willman.—29.

7. *Cleveland Section.*—B. H. Broadbent, **S. W. Chase*, R. P. Dressel, T. J. Hill, W. M. Krogman, V. C. Myers, W. A. Price, F. C. Waite.—8

8. *Columbus Section.*—H. C. Brown, A. J. Bush, H. V. Cottrell, **P. C. Kitchin*, R. D. McFarland, S. J. Randall.—6

9. *Halifax Section.*—J. S. Bagnall, R. J. Bean, O. W. Clough, A. W. Faulkner, A. B. Haverstack, Donald Mainland, W. C. Oxner, S. G. Ritchie, G. K. Thomson, E. G. Young.—10. (*H. M. Eaton*, an associate member, is Secretary of the Section.)

10. *Johannesburg Section.*—G. Friel, J. C. M. Shaw, **W. A. Wilson.*—3

11. *London Section.*—Arthur Bulleid, J. F. Colyer, F. N. Doubleday, E. W. Fish, C. H. Howkins, H. C. Malleson, G. B. Pritchard, **Evelyn Sprawson*, J. G. Turner.—9

12. *Louisville Section.*—T. B. Beust, **R. E. Myers*, J. T. O'Rourke, W. M. Randall.—4

13. *Minnesota Section.*—W. D. Armstrong, L. T. Austin, E. S. Best, P. J. Brekhus, J. T. Cohen, I. A. Epstein, B. S. Gardner, C. J. Grove, J. F. McClendon, F. S. Meyer, W. R. Schram, E. C. Stafne, W. D. Vehe, H. F. Wahlquist, C. W. Waldron, **H. G. Worman.*—16

14. *New Haven Section.*—B. G. Anderson, S. S. Arnim, C. G. Burn, A. M. Crosby, R. G. Hussey, H. A. Miller,* *J. P. Pigott*, David Weisberger, J. J. Wolfe.—9

15. *New York Section.*—Edmund Applebaum, H. A. Bartels, Adolph Berger, S. N. Blackberg, Theodor Blum, C. F. Bödecker, L. R. Cahn, M. W. Carr, G. W. Clapp, W. H. Crawford, H. S. Dunning, W. B. Dunning, H. S. Dwyer, J. D. Eby, Genevieve Foley, W. J. Gies, H. W. Gillett, W. K. Gregory, Samuel Greenberg, Milo Hellman, I. Hirschfeld, Franklin Hol-

lander, R. G. Hutchinson, Jr., T. P. Hyatt, A. L. Johnson, Maxwell Karshan, F. C. Kemple, Frances Krasnow, H. J. Leonard, E. C. McBeath, J. O. McCall, F. S. McKay, A. H. Merritt, E. G. Miller, Jr., Egon Neustadt, B. B. Palmer, **Theodor Rosebury*, A. T. Rowe, M. I. Schamberg, Joseph Schroff, H. H. Shapiro, F. L. Stanton, P. R. Stillman, L. M. Waugh, B. W. Weinberger, J. L. Zemsky, D. E. Ziskin.—47

16. *Philadelphia Section.*—J. L. T. Appleton, Jr., Carrie K. Bryant, **T. J. Cook*, J. A. Detlefsen, L. I. Grossman, R. H. Ivy, J. V. Mershon, Hermann Prinz, C. R. Turner.—9

17. *Pittsburgh Section.*—T. W. Brand, J. J. Enright, W. L. Fickes, F. C. Friesell, H. E. Friesell, E. G. Meisel, N. C. Ochsenhirt, W. F. Swanson, **L. E. Van Kirk*, E. A. Wolf, W. H. Wright.—11

18. *Prague Section.*—Karel Černý, Ján Jesenský, František Kostečka, Jaromir Křečau, A. E. Loos, V. F. Náprstek, **Friedrich Neumann*, František Neuwirt, Čestimir Parma, Josef Přibyl, Ferdinand Škaloud, Karel Wachsmann, Jr., Karel Wachsmann, Sr., Hans Wermuth.—14

19. *Richmond Section.*—Harry Bear, S. F. Bradel, **J. C. Forbes*, Harry Lyons, J. B. Williams.—5

20. *Rochester Section.*—B. G. Bibby, A. D. Brashear, R. E. Brawley, C. D. M. Day, H. C. Hodge, H. J. Sedwick, W. E. Taylor, **Grant Van Huysen*.—8

21. *St. Louis Section.*—E. H. Keys, B. E. Lischer, E. B. Owen, H. R. Raper (Albuquerque, N. M.), **C. O. Simpson*, R. C. Wheeler, J. D. White, G. B. Winter.—8

22. *San Francisco Section.*—G. L. Bean, Hermann Becks, W. C. Fleming, J. R. Gill, I. W. D. Hackh, G. M. Hollenbeck, J. A. Marshall, E. H. Mauk, G. S. Millberry, R. W. Rule, **W. B. Ryder*, Jr., E. W. Schultz, J. S. Shell, F. V. Simonton, L. B. Taber, R. C. Zeisz.—16

23. *Toronto Section.*—H. K. Box, **A. J. Broughton*, Thomas Cowling, A. W. Ellis, G. W. Grieve, F. C. Husband, A. J. McDonagh, E. W. Paul, R. J. Reade, H. S. Thomson, W. C. Trotter, A. E. Webster.—12

24. *Vienna Section.*—Arved Berg, Karl Breitner, **Fritz Driak*, Bernhard Gottlieb, Richard Grohs, Otto Hofer, Ernst Kellner, Emerich Kotanyi, Hermann Mathis, Balint Orban, Hans Pichler, Otto Preissecker, Franz Schönbauer, A. M. Schwarz, Harry Sicher, Karl Spring, Georg Stein, Richard Trauner, Herman Wolf, Josef Weinmann.—20

25. *Washington Section.*—A. B. Crane, C. W. Camalier, H. T. Dean, H. E. Harvey, Aleš Hrdlička, Aaron Isaacs, Harry Kaplan, R. A. Keilty, C. T. Messner, **G. C. Paffenbarger*, Wilmer Souder, E. R. Stone, W. T. Sweeney, N. O. Taylor (Minneapolis).—14

26. *Winnipeg Section.*—**E. R. Bier*, F. T. Cadham, M. H. Garvin, K. M. Johnson, H. J. Merkeley, W. J. Riley.—6

27. *Not now members of a section. Chicago.*—H. E. Benedict, R. H. Fouser, F. B. Moorehead. *Denver.*—K. K. Cross. *Germany.*—Wilhelm Dieck, Guido Fischer, Gustav Korkhaus, Otto Loos, Friedrich Proell, Rudolf Weber. *Glasgow.*—Andrew Hunter. *Hartford.*—R. L. Coleman. *Holland.*—T. E. de Jonge-Cohen, S. F. Gottlich, Elkan Sanders. *Honolulu.*—M. R. Jones. *Iowa City.*—A. W. Bryan, C. L. Drain, G. S. Easton, R. H. Volland. *Italy.*—Gyula Csernyei, Silvio Palazzi. *Montevideo.*—F. M. Pucci. *Newark.*—Henry Klein. *Omaha.*—R. W. Leigh. *Toronto.*—Mrs., R. F. Farquharson. *Winnipeg.*—Anne G. E. Mackenzie. *Zurich.*—Walter Hess.—28

Total number of members—360; average membership of twenty-six sections.—13

II. Note on the William J. Gies Fellowship in Biological Chemistry at Columbia University[3]

Edgar G. Miller, Jr., Ph.D., Chairman of the Fellowship Committee

The seventh Fellow, to serve for 1934–35, is Miss Sarah Ratner, A.B. (Cornell, 1924), A.M. (Columbia, 1927), who is conducting a study of the iron content of teeth in animals rendered experimentally anemic, and also of the position of the double bond in cholesterol.

During the calendar year 1934, work done under the auspices of the Fellowship was described in the following papers:

R. M. Herbst[4] and H. T. Clarke.—Oxidation of amino acids by silver oxide: *J. Biol. Chem., 104,* 769; Mar.

J. S. Fruton[5] and H. T. Clarke.—Chemical reactivity of cystine and its derivatives: *Ibid., 106,* 667; Sep.

Theodor Rosebury.[6]—Presence of iron in enamel keratin: *J. Den. Res., 14,* 269; Aug.

Lewis L. Engel.[7]—A method for the determination of iron in dental enamel: *Ibid., 14,* 273; Aug.

[3] Reports have been published annually in the *J. Den. Res.*, as follows: (1) 1927, vii, p. 530; (2) 1928, viii, p. 679; (3) 1929, ix, p. 741; (4) 1930, x, p. 771; (5) 1931, xi, p. 912; (6) 1932, xii, p. 1001; (7) 1933, xiii, p. 532.

[4] Fellow in 1931–32.

[5] Fellow in 1932–33.

[6] Fellow in 1928–30.

[7] Fellow in 1933–34.

The Fellowship is open to dentists, for graduate biochemical work in dental relationships. Although it was hoped the Fellowship would be particularly useful for the encouragement of graduate study by dentists, none of the recent applicants held the degree of D.D.S. or D.M.D.

The financial status of the Fund is indicated below:

Principal of the William J. Gies Fellowship Fund, held by Columbia University on June 30, 1933, as recorded in the last annual statement	$33,989.58
Addition to the *principal* of the Fund in 1933–34:	
One-half of the income for 1933–34[8]	849.73
Total amount of the principal, June 30, 1934	$34,839.31
Prospective stipend for the incumbent Fellow in 1934–35[8]	$827.43
Increase in the *principal* of the Fund (1928–34)	$7,452.25

III. Quotations: Dental Journalism

Assembled from pages 3 and 4 of the covers of the February and April numbers of this volume

Quotation from editorial comment on the desirability of withholding support from commercial dental journals. . . . The profession does not need the commercial journals, but the commercial journals need the profession. Backers of commercial journals are simply using the profession as a means of making money. . . . The more eminent the writer, the more valuable the article, the more imperative that publication be professional in every aspect and surrounding. The spirit of the past and the duty of the present is to present every valuable bit of knowledge directly to the profession, and, negatively, to refuse it to those who will exploit it for commercial gain. . . .There is all the difference in the world between the use of advertisements to meet deficits in the publishing of professional articles, and the contrary use of a few professional articles to justify and facilitate the dissemination of large masses of advertisements. . . .Dentists conscious of their pro-

[8] Goodridge, Howe, Dunning, and Waugh: *J. Den. Res.*, 1927, vii, p. 530. From 1928–1937, inclusive, 50 percent of the annual income will be added to the principal amount of the Fund; from 1938–1947, inclusive, 30 percent; from 1948–1957, inclusive, 10 percent. Beginning in 1958 (January 1), the whole of the annual income will be available for current use.

fessional character will only consider those journals as truly representative of their ethics which are operated on the first, and which refuse to follow the second, plan. . . . The professional men who are connected with. . .[commercial dental journals] should, in deference to their professional status, sever a connection with the commercial world which is undesirable and which tends to lower the standards of dentistry and medicine.—*Apollonian, 1934, Jan.*

Quotation from editorial comment suggesting that members of dental faculties should refrain from contributing articles to commercial dental journals. There is a clear and sharp line of demarkation between professional and commercial dental literature. The first publishes information and prints a few advertisements which help to support it—the second publishes advertisements and prints a few articles to give respectability to the advertisements. . . .This does not apply to the harmless trade-house journals; that is, the house organs of supply firms which keep the profession informed as to their novelties; but it applies to all those business organizations which publish periodicals filled with unreliable and uncensored advertisements of nostrums and quack-remedies. Dentists may think they receive these periodicals "free," but on second thought they will find that they "pay for it," for the advertising firms must find their advertisements lucrative, and the publishers earn their profits. The simplest way to stop this nefarious practice is for all ethical dentists to refuse to write articles for such commercial papers. The dental faculties may well take the lead and request from their members that they agree not to write for commercial dental periodicals.—*I. H.; Contact Point, 1934, Feb.*

Quotation from editorial discussion of Dr. E. S. Best's commendation of commercial dental journalism. . . .These magazines [commercial dental journals], according to Dr. Best, are written and edited for the profession, but it is well known they are actually published for the benefit of their supply-house owners. . . .From the Report of the American College of Dentists' Commission on Journalism we learn that the *Dental Survey*, of which Dr. Best is editor, is fundamentally a profit-seeking publication; and that, as one of its three owners, Dr. Best has a very practical interest in its financial success. His editorial, in which he attempts to justify and extol commercialized journal-

ism, is therefore understandable as the effort of a person endeavoring to protect and advance his monetary interests.—*C. F. H.; Bulletin of the Hudson County [N. J.] Dental Society, 1934, Feb.*

Below we [*J. Den. Res.*] give three quotations from journals published by dental students. These journals represent the insight, idealism, courage, and professional purpose of a coming generation of dental editors. Dental-school journals are practical agencies for the development of future leaders in dental journalism—leaders who will care more to serve the public causes of a profession than the private interests of a trade-house. We commend such editors to the consideration of dental faculties, and the dental-school journals to the support of dentists generally.

. . . .The editors and publishers of proprietary journals claim that their journals are published for the good of the dental profession and not with an eye to the promotion of the trade houses and dental products of their owners. The editor of one prominent proprietary dental magazine has gone so far as to assert that his particular publication appears "in the interest of the patient.". . .All periodicals are published primarily for their owners. . . .But what of the underlying motive? A trade-house owner will take care that his products are not slighted and a publishing house owner will not allow his books, or their authors, to be slighted. A journal published by a dental society is likewise published for the benefit of its owners; and who are its owners but members of the dental profession? Such a journal is published for dentists in fact, not merely in dedication. Therein lies the real difference between proprietary and non-proprietary journalism. . . .—*Editorial: Penn Dental Journal, 1934, xxxvi, pp. 87–88; Jan.*

To the undergraduate it may seem incredible. . .that the profession of dentistry should have had to depend upon a non-professional group of advertisers, or upon a few commercially subsidized dentists for its literature. Yet. . .the profession has been needlessly and—worse—carelessly allowed to become dependent upon a purely commercial combine for its fundamental right of expression. . . .Although this present generation of students cannot remember the effective suppression of the proprietary dental schools in America, we may perhaps be fortunate enough to see dentistry finally strike off the shackles of proprietary journalism, with its garbled commercial sophistry, and watch it emerge a truly unified and universally respected profession.—*T. C. Agins,* '34; *Tufts Dental Outlook,* 1934, viii, pp. 15–17; March.

. . . .For a magazine like *Dental Survey* to present a medal to some dentist appears like a rather nice gesture. It might be looked upon a bit askance, perhaps, but there isn't anything really wrong about it. But, when this medal is given and the award made in line with the magazine's usual policies of commercialism, we're inclined to view it a little differently and question the professional ethics of the dentist who is editor of the magazine. And it follows, "as the night the day," that we likewise question the professional integrity and ideals and ethics of the "prominent" dentists who aid and abet such a proceeding. . . .—*T. McB.*: *Dental Rays* (School of Dentistry, University of Pittsburgh), 1934, ix, p. 35; March.

ADDENDUM. *Quotation from page ii of the cover of the issue of the J. Den. Res. for December 1933.* Schools and journals are among the most important agencies for the education of prospective and present members of a profession. Each of these influential agencies should be conducted at the highest attainable levels of public-spiritedness, of professional character, and of educational responsibility. Each should be free from the selfish influences associated with commercial exploitation. The public interests inherent in these educational agencies for the development of professions should not be subordinated to mercenary purposes. In accordance with these accepted principles, the dental profession wisely brought about the discontinuance of *proprietary* dental *schools*. Why, then, should a large proportion of the dental profession continue to support the moribund system of *proprietary* dental *journals*? Can any one give to this question an answer that will reflect credit upon the intelligence, disinterestedness, and professional fidelity of the dentists who help these journals to pay profits to their owners.

The editorial in *Dental Digest* for November, 1933, defending commercial exploitation of dental journalism, seeks to remove from the term "proprietary" the implications which some dentists in trade-house employ find very troublesome. The editorial explains, by recourse to the *etymology* of "proprietary," that "all dental journals . . . . are property and therefore proprietary." This is obvious, and what of it? The editorial ignores the most important fact in this connection; namely, that words signify not merely what their *etymology* indicated when they were *coined*, but also (sometimes instead) the import that *usage* gives them. Many words have thus acquired meanings that supplement or are inconsistent with their

original significance. "Vitamin," for example, was coined to designate a substance which, believed to be essential for life, was assumed to be an *amino* compound. Later, it was found that this assumption had not been justified. Since, however, the term could be *conveniently* retained as a general *label* for a group of unlike substances of similar functional influences, "vitamin" now carries a common meaning that disregards much of its *etymological* significance. Originally, "medicine" meant to *cure* disease; now the best of its several meanings is to *prevent* disease, i.e., to make cure unnecessary. Illustrations might be multiplied. "Proprietary," as applied to dental *schools*, has long meant not only that such schools were property, which is self-evident, but also, and more significantly, that they were *conducted primarily for private profit to their owners, and had all the educational disabilities ensuing from that undesirable condition.* "Proprietary," as applied to dental *journals*, has been generally used to indicate similar subordination of professional interests to private devices. The present concerted effort by spokesmen for dental trade, to remove from the *use* of "proprietary" as applied to dental journals this meaning that indicates a serious infirmity, will have only one effect; namely, to emphasize the pertinence and usefulness of this common usage. Proprietary dental journals, which usually profess "devotion to the profession" but lack the candor to avow their dominant financial objectives, are now endeavoring to divert attention from their inherent disability by giving themselves such euphonious titles as "independent." This painful effort to remove the recognized stamp of undesirability might be pathetic if it were not ridiculous. The following fair and frank comment in the Carnegie Foundation's *Bulletin on Dental Education* (1926) is repeated here with emphasis on its continuing validity:

"Some of . . . [the dental journals], because of their mercenary character, detract seriously from public respect for the profession that supports them" (page 35). "Dental manufacturers and supply houses have been remarkably successful in the production and distribution of invaluable merchandise, and the advanced practice of modern dentistry would be impossible without a continual abundance of the best products of the dental industries. . . . Dental business, having been effectually organized, is competent to continue and to develop this important public service, *which alone is more than sufficient to tax its greatest ingenuity and all of its integrity.* . . . Unfortunately, however, dental business essays to be rather the mentor of dentistry than its faithful and effective assistant, and presumes continually to advise and to guide the profession. The relatively weak resistance of dentistry to commercial cajolery, as evidenced in the resuts that are being continually obtained among dentists by producers and distributors of supplies, has encouraged dental manufacturers and supply houses persistently to intrude selfish influences into almost every phase of dental affairs. . . . *No other profession appears to respond so spontaneously to infantile advertising*" (pp. 147–48).

I predict with confidence that self-respecting dentists, faithful to their professional obligations, will, in cumulatively increasing number, demand financial disinterestedness from all journals which, *issued in the name of dentistry*, seek to influence dentists and to mould the development of the dental profession.—*William J. Gies, Columbia University, December 1, 1933.*

IV. Correction

Frances Krasnow, M.A., Ph.D.

The last sentence in abstract 96, on page 227, designated "100 mg." [milligram] instead of *100 gm.* [gram] as the basic mass. The said sentence should read: In enamel and dentin from 15 teeth, content of lipid-P per *100 gm.* was 0.5 to 2.8 mg., and 0.1 to 1.7 mg., respectively.

INDEX

Volume XIV: 1934

SPECIAL ABBREVIATIONS: *A. A. D. S.* = American Association of Dental Schools. *A. D. A.* = American Dental Association. *I. A. D. R.* = International Association for Dental Research. *J. D. R.* = Journal of Dental Research.

ACIDS: action on enamel; relationship of pH, Ca and P in acid solvents, 220. *See also* Caries, Citrate, Saliva

Address: I. A. D. R.; president's, 154, 187

——: ——; president-elect's, 187

Age: maxillary sinus; relation of teeth to floor, 235

——: ——; relation to form, size, and position, 234. *See also* Teeth

AGINS, T. C.: dental journalism; quotation, 477

AGNEW, M. C. and R. G.: aborigines of Tibetan borderland; diet and dentition, 210

Agranulocytosis: periodic; blood conditions, 176, 321

——: ——; oral conditions, 176, 315

AISENBERG, M. S.: maxillary frenum; anatomy, 210

Allergy: periodontal disease, 178

Alloys: gold-copper; hardness variations, 181, 349. *See also* Amalgam

Amalgam: copper; mercury non-toxic, 165

——: ——; properties, 165

——: crystalline; cadmium, lead, tin, zinc—composition, 33. *See also* Alloys

Ameloblastomata: differentiation from dentigerous cysts, 175

Amer. Assoc. Dent. Sch.: president's greetings; I. A. D. R., 182

Amer. Den. Assoc.: dental health survey with U. S. Public Health Service; report, 183

ANDERSON, G. M.: maxillary frenum; anatomy, 210

Anemia: aplastic; effects of oral treatment on blood picture, 379

Anesthetic: local; nupercaine, 218

Angle Class II. *See* Teeth

Antivirus. *See* Besredka antivirus

Apatite: "inorganic residue" of teeth; resemblance, 264

——: solubility; saliva, 165

——: solution rate; average mouth, 455

Apollonian: dental journalism; quotation, 475

Apparatus. *See* Method

APPLEBAUM, EDMUND: bands of Schreger; relation to calcification of enamel, 219

APPLETON, J. L. T., Jr.: acceptance of presidency; I. A. D. R. (1934–35), 187

——: Besredka antivirus; protective, 165

——: brushing teeth; effect on bacterial growth, 164

ARMSTRONG, W. D.: apatite; solution rate in average mouth, 165, 455

——: separation of enamel from dentin and cementum; method, 174

——: teeth; composition, 162

Articulator. *See* Denture

ASHER, H. H.: gold-copper alloys; hardness variations, 181, 349

BACILLUS acidophilus: relation to caries, 104, 162. *See also* Lactobacillus

Bacteria: dental calculus, 237

——: growth; action of saliva, 164

Bacteria: growth (*con.*); mouth—effect of brushing teeth, 164
——: intracellular; dental granuloma, 297
See also B. acidophilus, Cocci, Infection, Lactobacillus, Streptococci
BALE, W. F.: dentin; x-ray absorption, 168
Bands of Schreger: relation to calcification of enamel, 219
BECKS, HERMANN: root-end resorption; conditions, 180
——: salivary Ca; review, 161, 387
BERKE, J. D.: dentition; influence of parathormone, 211
Besredka "antivirus": protective, 165
BEUBE, F. E.: alveolar and maxillary bone; regeneration with devitalized heterogeneous bone-powder, 15
BEUST, T. B.: teeth with pulpal involvement; permeability tests, 93, 163
BIBBY, B. G.: gram-negative cocci; mouth, 163
Bibliography: dental; methods of compilation, 145, 219
Biopsy: importance; early diagnosis of lip carcinoma, 167
Birth: first permanent molar. *See* Teeth
——: frenum labii; anatomy, 159
Bisulphite. *See* Sulphur dioxide
BLACKBERG, S. N.: dentition; influence of parathormone, 211
——: radium poisoning; changes in teeth and jaws, 211
BLAUCH, L. E.: survey of dental curriculum; general purpose, 184
Blood: aplastic anemia; effect of oral treatment, 379
——: periodic agranulocytosis, 176, 321
——: sugar; periodontal disease, 206
BÖDECKER, C. F.: bands of Schreger; relation to calcification of enamel, 219
Body: growth; correlation with eruption of incisor, 139, 236
——: ——; correlation with growth of teeth, 346
——: measurements; relation to caries, 439
Bone: alveolar; regeneration—influence of devitalized heterogeneous bone powder, 15
Bone (*con.*): appositional substitution of dentin, 174
——: development; correlation with eruption of incisors, 139, 236
——: maxillary; regeneration—influence of devitalized heterogeneous bone powder, 15
BOUCHER, C. O.: functional movements of full-denture bases in three dimensions; method of recording, 39
BOYLE, P. E.: dental granuloma; intracellular bacteria, 297
——: tooth germ; acute scurvy, 172
BRASHEAR, A. D.: pulp; neurons, 159
BRAWLEY, R. E.: saliva of children; effects of vitamins A and D on pH, 211
BREKHUS, P. J.: apatite; solution rate in average mouth, 165, 455
——: separation of enamel from dentin and cementum; method, 174
——: teeth; composition, 162
BREUER, KARL: periodontal disease; basic metabolism and specific dynamic effect of protein, 207
——: ——; blood sugar, 206
——: ——; hepatic function, 207
BRODIE, A. G.: hypopituitary patient; changes in jaws and teeth, 166
BROWN, J. B.: saliva; correlation of composition and secretion, 435
BROWN, R. K.: personality surveys; dentists, 178
Brushing teeth. *See* Teeth
BUNTING, R. W.: caries; Michigan Research Group—review, 97, 162
Bureau of Standards. *See* National Bureau of Standards

CADMIUM: crystalline amalgams; composition, 33
Calcification: pulp, 160. *See also* Calcium, Calculus
Calcium: acid solvents; relation to action on enamel, 220
——: dietary deficiency; caries study, 359
——: metabolism; caries association, 312
——: saliva; method, 171, 425

Calcium: saliva (*con.*); review, 161, 387
See also Blood, Bone, Caries, Enamel, Saliva, Teeth
Calculus: dental; bacteria, 237
——: salivary; prevention, 207
Camphor: carbolated; properties, 205
Carcinoma: basal cell; dental cyst, 190
——: lip; early diagnosis—importance of biopsy, 167
Caries: children; effects of vitamins A and D, 213
——: ——; puberty, 214
——: Columbia Univ. Research Group; review, 303
——: dental plaque; pH, 218
——: etiology; local *and* systemic, 312
——: ——; local, *not* systemic, 439
——: ——; relation of heredity, 216, 217
——: extracts of dentin and enamel; composition, 445
——: fissure; etiology, 234
——: food retention; association, 312
——: immunization; rats, 231
——: incidence; monkeys, 221
——: ——; wild rats, 221
——: lactobacilli; rats, 231, 232. *See also* B. acidophilus
——: Michigan Research Group; review, 97, 162
——: mothers and young; deficient diets during pregnancy, lactation, and rearing, 359
——: nutrition; Eskimos and Indians, 227
——: relation of salivary amylase, 213
——: relation of systemic conditions and diseases, 439
——: saliva; composition, 163
——: sclerosis of dentin; factor in resistance, 96, 163
——: sugar; factor, 104, 162
——: susceptibility; rat, 234
——: teeth with pulpal involvement; permeability, 93, 163
——: women; relation of body measurements and diseases, 439
See also Bacteria, Dentin, Diet, Enamel, Teeth
Cementoma: x-ray evidence; incidence and phases, 181
Cements: silicate; pH—influence of conditions of mixing, 169
Cementum: odontoblasts; club-shaped processes, 188
——: separation from enamel and dentin, 174
CHASE, H. C.: citrate solutions; acidity and action on enamel, 212
Chewing: reflex effects; gastric secretion, 6
Children: caries; effects of vitamins A and D, 213
——: ——; puberty, 214
——: first permanent molars; percentage of perfect sets, 216
——: mentally defective; frequency of oral signs of degeneration, 209
——: puberty; caries, 214
——: ——; hard palates, 236
——: saliva; effects of vitamins A and D on pH, 211
See also Caries, Malocclusion, Teeth
Cholesterol: teeth and saliva; amounts, 226
——: ——; correction, 480
CHURCHILL, H. R.: dentigerous cysts and ameloblastomata; differentiation, 175
——: epulis; localized osteitis fibrosa, 175
——: sheath of Neumann; optical illusion, 243
Citrate solutions: acidity; action on enamel, 212. *See also* Acids
Civilization: Eskimos and Indians; degenerative influences, 227, 229, 230
Clasp: fixation. *See* Denture
——: non-torque; mandibular partial denture, 457
——: teeth; protection, 200
CLOUGH, O. W.: saliva; effects on bacterial growth, 164
Cocci: mouth; gram-negative strains, 163
Columbia Univ.: caries research group; review, 303
——: Gies Fellowship; Biol. Chem., 474
Composition: saliva; correlation with secretion, 435
——: teeth, 162

Copper-gold alloys: hardness variations, 181, 349. *See also* Amalgam
Coprophagy: rats; influence on mouth anerobic flora, 232
Correction: cholesterol and lecithin; teeth and saliva, 480
Council on Dental Therapeutics: accomplishments and obstacles, 183
CROWELL, C. D.: teeth; composition, 251
CUNNINGHAM, R. L.: caries; relation to disease, menstrual experience, and physical measurements of young women, 439
Curriculum: dental; survey—general purpose, 184
Cyst: dental; basal-cell cancer, 190
——: dentigerous; differentiation from ameloblastomata, 175
——: oral; treatment, 204
——: Partsch operation; modification, 188

DAGGS, R. G.: high-sugar diet; no effect on teeth, 215
DAHLBERG, A. A.: tooth elements; heterotopic formation, 172
DAY, C. D. M.: amylolytic enzyme of saliva; relation to caries, 213
——: dental dystrophies during lactation, 212
——: high-sugar diet; no effect on teeth, 215
——: puberty; caries, 214
——: ——; hard palate, 236
——: vitamins A and D; caries in children, 213
Degeneration: oral signs; frequency in mentally defective children, 209. *See also* Civilization
Dens in dente: review; new instance, 49
Dental diseases: pre-Columbian Indians; skulls, 235. *See also* Teeth
Dental education: curriculum survey; general purpose, 184
Dental health-survey: A. D. A. and U. S. Public Health Service; report, 183
Dental journalism: proprietary control; opposed, 475
——: student periodicals; commended, 477
See also Dental Periodical Literature (Index), *J. Den. Res.*
Dental Periodical Literature: Index; based on erroneous principle, 148, 219. *See also* Dental journalism
Dental research: National Bureau of Standards, 184
Dental Therapeutics: Council; accomplishments and obstacles, 183
Dentin: appositional substitution by bone, 174
——: changes; under fillings, 169
——: circumtubular areas; double staining, 243
——: extracts; caries study, 445
——: sclerosis; factor in resistance to caries, 96, 163
——: separation from enamel and cementum, 174
——: sheath of Neumann; optical illusion, 243
——: x-ray absorption; comparative data, 168
See also Caries, Teeth
Dentists: personality surveys, 178
Dentition: development; dangerous stages, 225
——: influence of parathormone, 211
——: polyisomerism, 125, 236
See also Diet, Teeth
Dento-facial relations. *See* Face
DENTON, G. B.: full denture; changing principles of retention and design, 170
Denture: full; bases—record of functional movements in three dimensions, 39
——: ——; principles of retention and design, 170
——: partial; mandibular—non-torque clasp, 457
——: ——; new clasp-fixation, 200
See also Jaw, Teeth
DETLEFSEN, J. A.: etiology; quantitative evaluation, 216
——: first permanent molars; percentage of perfect sets, 216
——: malocclusion; affected by extraction, 217
Diagnosis: early in carcinoma of lip; importance of biopsy, 167
——: unilateral distal occlusion, 223
Diathermy. *See* Surgery

Diet: caries; rat, 234
——: caries-producing; effect of addition of lactobacilli, 231
——: ——; immunization against lactobacilli, 231
——: deficient; caries—mothers and young during pregnancy, lactation and rearing, 359
——: dental dystrophies; during lactation, 212
——: high-sugar; no effect on teeth, 215
——: relation to influence of parathormone on dentition, 211
——: teeth; aborigines of Tibetan borderland, 210
See also Nutrition, Teeth
Digestion: gastric; effects of saliva, 3
——: salivary; relation to caries, 213
Disinfection: pulp canals and periapical tissue; surgical diathermy, 29
DIXON, R. A.: pulp and dentin; changes under filling materials, 169
DOBBS, E. C.: nupercaine; local anesthetic, 218
DONALDSON, H. H.: molar teeth; growth after eruption, 158, 323
DRIAK, FRITZ: carbolated camphor; properties, 205

EBERLY, J. A., Jr.: pH of silicate cements; influence of conditions of mixing, 169
Electric waves: short; action on streptococci, 459
Electrotherapy. *See* Surgery
Enamel: action of acid citrate solutions, 212
——: bands of Schreger; relation to calcification, 219
——: Ca and P contents; relation to age and state of teeth, 28
——: extracts; caries study, 445
——: iron content; method, 273
——: keratin; iron, 269
——: molars; growth after eruption, 158, 323
——: separation from dentin and cementum, 174
——: solubility; in saliva—caries, 163
Enamel: solubility (*con.*); relationship of pH, Ca and P in acid solvents, 220
——: solution velocity, 21
See also Caries, Dentin, Teeth
ENGEL, L. L.: iron in enamel; method, 273
Enzyme: saliva; amylolytic; relation to caries, 213
——: ——; autolytic, 205
——: ——; proteolytic, 205
Epinephrine: preservative; bisulphite, 177
Epithelial rests: region of palatinal papilla, 187
Epulis: localized osteitis fibrosa, 175
Eskimos: diet and caries, 227
——: facial deformity and dental irregularities; etiology, 229
——: infections; susceptibility, 230
ETHERINGTON, J. W.: dental plaques; pH, 218
Etiology: caries; relation of heredity, 104, 162, 216, 217
——: facial deformity and dental irregularities; Eskimos and Indians, 229
——: malocclusion; heredity important, 216, 217
——: quantitative evaluation, 216
Extraction: teeth. *See* Surgery, Teeth

FACE: deformity; etiology among Eskimos and Indians, 229
——: dento-facial relations; new instrument for measurement, 226
——: ——; teleroentgenograms, 224
——: ——; variations—individual and racial, 227, 277
Facio-dental relations. *See* Face
Feces: ingestion. *See* Coprophagy
Ferments. *See* Enzymes
Filling materials: changes in pulp and dentin, 169. *See also* Amalgam, Cements
Fillings: occlusal; extension to include defective fissures, 203
FINK, E. B.: carcinoma of lip; importance of biopsy in early diagnosis, 167
FLINN, F. B.: radium poisoning; changes in teeth and jaws, 211
Flora: mouth. *See* Bacteria, Mouth
Fluorine: effects; incisor eruption, 139, 236

FOLEY, GENEVIEVE: caries; effects, in mothers and young, of diets deficient in Ca and vitamin D, during pregnancy, lactation, and rearing, 359
——: ——; effects of feeding lactobacilli with caries-producing diets, 231
——: ——; immunization, on caries-producing diets, against lactobacilli, 231
——: ——; influence of coprophagy on mouth flora, 232
——: etiology of fissure caries, 234
Formaldehyde. *See* Paraformaldehyde
FOSDICK, L. S.: gastric digestion; effects of saliva, 3
——: saliva; relation to caries, 163

GABEL, A. B.: non-torque clasp; mandibular partial denture, 457
Gastric conditions: contents; effects of saliva, 3
——: digestion; effects of saliva, 3
——: ——; effects of salivary mucin, 12
——: secretion; reflex effects of chewing, 6
Genital glands: factor; etiology of paradentitis, 208
Gies Fellowship: Biol. Chem., Columbia Univ.; financial status, 474
——: ——; open to dentists, 475
——: ——; papers published (1934), 474
GIES, W. J.: dental journalism; quotation, 478
——: I. A. D. R.; list of membership and sections, 471
——: ——; proceedings, 153
——: *J. D. R.*; transfer of ownership, 1, 67, 237, iii
——: this Index, 481
Gingivitis: allergic nature, 178. *See also* Periodontal disease
Gold-copper: alloys; hardness variations, 181, 349
GORDON, S. M.: solutions of procaine and epinephrine; sulphur dioxide (bisulphite) preservative, 177
Granuloma: dental; intracellular bacteria, 297
GREENBERG, SAMUEL: caries; immunization, on caries-producing diets, against lactobacilli, 231
GREENBERG, SAMUEL: caries (*con.*); influence of coprophagy on mouth flora, 232
GROHS, RICHARD: epithelial rests; region of palatinal papilla, 187
Growth: bacteria; action of saliva, 164
——: ——; effect, in mouth, of brushing teeth, 164
——: dentition; dangerous stages, 225
——: first permanent molar; postnatal, 158
——: molar teeth; after eruption, 158, 323
See also Body-growth

HACKH, INGO: bibliographic methods; dentistry, 145, 219
——: dental journalism; quotation, 476
HANSEN, H. L.: saliva; relation to caries, 163
HARPER, C. F.: dental journalism; quotation, 476
HARRIS, F. E.: copper amalgam; properties, 165
HATTON, E. H.: presidential address; Louis-Charles Malassez, 154, 187
Health survey. *See* Dental health survey
HEALY, J. C.: periodontal diseases; allergic nature, 178
Herbst retention-appliance: treatment of Angle Class II, 201
Heredity. *See* Inheritance
HILTZ, J. E.: mandible; muscles of occlusion, 107
H-ion concentration. *See* pH
HODGE, H. C.: dentin; x-ray absorption, 168
——: teeth; composition, 251
HOFER, OTTO: Partsch cyst operation; modification, 188
HOLLANDER, FRANKLIN: bands of Schreger; relation to calcification of enamel, 219
——: Columbia Univ. Caries Research Group; review, 303
HOSFORD, H. H.: crystalline amalgams of cadmium, lead, tin, and zinc; composition, 33
HUGGINS, C. B.: appositional substitution; dentin by bone, 174
——: tooth elements; heterotopic formation, 172

Hypophysis: hypophysectomy; influence on teeth, 69
——: hypopituitary patient; jaws and teeth, 166

IMMUNITY. *See* Allergy, Caries, Besredka antivirus
Index to Dental Periodical Literature: basic principle; erroneous, 148, 219
Indians: diet and caries, 227
——: facial deformity and dental irregularities; etiology, 229
——: infections; susceptibility, 230
——: pre-Columbian skulls; dental diseases, 235
Infection: focal; treatment of pulpless deciduous teeth, 201
——: oral; effect of treatment on blood picture in aplastic anemia, 379
——: periapical; dental granuloma—intracellular bacteria, 297
——: susceptibility; Eskimos and Indians, 230
See also Bacteria, Disinfection, Caries, Teeth
Inheritance: caries, 104, 162, 216, 217
——: orthodontic anomalies, 202, 216, 217
Instrument. *See* Method
Int. Assoc. Den. Res.: *J. D. R.*; transfer of ownership, 1, 67, 237, iii
——: lists of members and sections, 471
——: new members, 239
——: new officers, 239
——: proceedings; abstracts, 153
——: ——; executive data, 237
——: ——; participants—index of names, 157
——: ——; presidency for 1934–35—acceptance, 187
——: ——; president's address, 154, 187
——: schedule of sectional meetings (1933–34), 471
Iron: enamel; keratin, 269
——: ——; method, 273

JAW(S): changes; radium poisoning, 211
——: hypopituitary patient, 166
Jaws (*con.*): upper; epithelial rests—region of palatinal papilla, 187
See also Denture, Mandible, Maxilla
JESERICH, P. H.: tube-form of post or dowel; availability for crown restorations on non-vital teeth, 170
Jour. Den. Res.: change of ownership, 1, 67, 237, iii
——: quotations; dental journalism, 475

KANTHAK, F. F.: enamel; velocity of solubility, 21
KARSHAN, MAXWELL: caries; effects of feeding lactobacilli with caries-producing diets, 231
——: enamel and dentin extracts; caries study, 445
——: etiology of fissure caries, 234
——: solubility of enamel; relationship of pH, Ca, and P in acid solvents, 220
KELLNER, ERNST: odontoblasts in cementum; club-shaped processes, 188
Keratin: enamel; iron, 269
KITCHIN, P. C.: periodic agranulocytosis; blood conditions, 176, 321
——: ——; oral conditions, 176, 315
KLEIN, HENRY: caries in monkeys; incidence, 221
——: caries in wild rats; incidence, 221
KLOTZ, N. J.: saliva; correlation of composition and secretion, 435
KORKHAUS, GUSTAV: dentition; dangerous stages in development—premature loss of deciduous teeth, 225
——: dento-facial relations; new instrument for measurements, 226
——: diagnosis of unilateral distal occlusion; identical twins, 223
——: malocclusions; self-correction, 221
——: teleroentgenograms of face; maxillo-facial relations, 224
KRAMP, E. H.: pulp canals and periapical tissue; diathermy, 29
KRASNOW, FRANCES: teeth and saliva; cholesterol and lecithin contents, 226
——: ——; correction, 480
KROGMAN, W. M.: facio-dental relationships; racial and individual variations, 227, 277

KRONFELD, R.: dens in dente, 49
——: first permanent molar at birth; postnatal growth and development, 158

LACTATION: deficient diet; caries study, 359
——: dental dystrophies, 212
Lactobacillus: caries; rats, 231, 232
——: fermentation; caries association, 312
See also B. acidophilus
LASBY, W. F.: president of A. A. D. S.; greetings to I. A. D. R., 182
Lead: crystalline amalgams; composition, 33
Lecithin: teeth and saliva; amounts, 226
——: correction, 480
LINE, W. R.: teeth; composition, 251
Lip: carcinoma; biopsy in early diagnosis, 167
——: frenum; anatomy at birth, 159
——: upper; cleft—surgical correction, 176
——: ——; muscles—attachment to maxilla, 176
Liver: function; periodontal disease, 207
LOGAN, W. H. G.: muscles of upper lip and attachment to maxilla; surgical correction of cleft of lip, 176
Louis-Charles Malassez: subject of presidential address; I. A. D. R., 154, 187
LUCKHARDT, A. B.: Council on Dental Therapeutics; accomplishments and obstacles, 183
LUNDQUIST, G. R.: replantation; dog teeth, 177

MAINLAND, DONALD: mandible; muscles of occlusion, 107
Malocclusion: etiology; heredity, 216, 217
——: relation of extraction, 217
——: self correction, 221
——: unilateral distal; diagnosis, 223
Mandible: forces; muscles of occlusion, 107
——: temporo-mandibular joint; articulation, 208
——: tumor; spontaneous healing, 190
Mastication: reflex effects; gastric secretion, 6
Maxilla: attachment of muscles of upper lip, 176
——: bone regeneration; influence of devitalized heterogeneous bone powder, 15
——: frenum; anatomy, 210
——: sinus; floor—relation of teeth, 235
——: ——; form, size, and position at various ages, 234
Maxillo-facial relations. *See* Face
MCBRIDE, T. F.: dental journalism; quotation, 478
MCCARROLL, H. R.: appositional substitution; dentin by bone, 174
——: tooth elements; heterotopic formation, 172
Menstruation: relation to caries, 439
Mental defectives. *See* Degeneration
Mercury: copper amalgam; non-toxic, 165
MESSNER, C. T.: dental health survey by A. D. A. with U. S. Public Health Service; report, 183
Metabolism: basic; periodontal disease, 207
——: Ca and P; caries association, 312
See also Diet, Nutrition
Method(s): bibliographic in dentistry; compared, 145, 219
——: dental surgery, 204
——: dento-facial relations; measurement, 226
——: diathermy; surgical, 29
——: functional movements; full-denture bases, three dimensions, 39
——: iron; enamel, 273
——: partial denture; clasp fixation, 200
——: pulp stain; silver bromide, 347
——: root resection, 204
——: salivary Ca; new, 171, 425
——: ——; review, 161, 387
——: separation of enamel from dentin and cementum, 174
——: surgical correction; cleft of lip, 176
——: teleroentgenography of face; for maxillo-facial relations, 224
——: x-ray absorption; dentin, 168
See also Treatment
Michigan Research Group: caries; review, 97, 162

MILLER, E. G., Jr.: Gies Fellowship in Biol. Chem., Columbia Univ.; annual report, 474
Mouth: anerobic flora; influence of coprophagy in rats, 232
——: average; solution rate of apatite, 165, 455
——: bacterial growth; effect of brushing teeth, 164
——: cocci; gram-negative strains, 163
——: conditions; periodic agranulocytosis, 176, 315
——: treatment; effects on blood picture in aplastic anemia, 379
Mucin: effects on gastric digestion, 12
Muscles: occlusion; forces on mandible, 107
——: upper lip; attachment to maxilla, 176

NÁPRSTEK, V. F.: etiology of parodentitis; genital factors, 208
——: teeth; prevention of calculus, 207
National Bureau of Standards: dental research, 184
Neumann's sheath: optical illusion, 243
Neuropathic children: oral signs of degeneration; frequency, 209
NEUWIRTH, FRANTIŠEK: pulp; "biologic" treatment, 208
New born. *See* Birth
NOYES, F. B.: suture; structure, 160
NOYES, H. J.: frenum labii in new-born infants; anatomy, 159
Nupercaine: anesthetic; local, 218
Nutrition: caries; Eskimos and Indians, 227
——: deficient; effects among Eskimos and Indians, 227, 229, 230
——: ——; relation to susceptibility to infections among Eskimos and Indians, 230
See also Diet, Metabolism

OARTEL, J. S.: short electric waves; effects on streptococci from infected teeth, 459
Occlusion: muscles; forces on mandible, 107. *See also* Malocclusion
Odontoblasts: cementum; club-shaped processes, 188
Operation: cyst; Partsch—modification, 188
ORBAN, BALINT: pulp; metaplastic changes induced by paraformaldehyde, 189
Orthodontia. *See* Face, Jaw, Teeth
Osteitis fibrosa: localized; epulis, 175

PALATE: hard; puberty, 236
——: papilla; nearby epithelial rests, 187
Paradental disease. *See* Periodontal disease
Paraformaldehyde: pulp; metaplastic changes, 189
Parathormone: influence on dentition, 211
PARMA, ČESTIMÍR: temporo-mandibular joint; articulation, 208
Partsch operation: cyst; modification, 188
Penn Dental Journal: dental journalism; quotation, 477
Pepsin. *See* Gastric conditions
Periapical: infection. *See* Infection
——: tissue; disinfection—surgical diathermy, 29
See also Pulp
Peridental membrane: structure; similar to suture, 160
Periodical Literature: Dental; Index—based on erroneous principle, 148, 219
Periodontal disease: allergic nature, 178
——: basic metabolism, 207
——: blood sugar, 206
——: genital glands; factors, 208
——: liver; function, 207
——: specific dynamic effect of protein, 207
Periodontoclasia. *See* Periodontal disease
PETTIT, L. S.: aplastic anemia; effects of oral treatment on blood picture, 379
pH: saliva of children; effects of vitamins A and D, 211
——: silicate cements; influence of conditions of mixing, 169
——: solvents; relation to action on enamel, 220

Phosphorus: acid solvents; relation to action on enamel, 220
——: metabolism; caries association, 312
See also Blood, Bone, Caries, Enamel, Saliva, Teeth
PICHLER, HANS: basal-cell cancer; dental cyst, 190
——: mandibular tumor; spontaneous healing, 190
Pituitary gland. *See* Hypophysis
Plaque: dental; pH, 218
POLEVITZKY, KATHERINE: Besredka antivirus; protective, 165
POLLOCK, FRANK: caries; influence of coprophagy on mouth flora, 232
Polyisomerism: human dentition, 125, 236
Pregnancy: deficient diet; caries study, 359
Presidency: I. A. D. R.; acceptance, 187
——: ——; address, 154, 187
PRICE, W. A.: Eskimos and Indians; diet and caries, 227
——: ——; facial deformity and dental irregularities, 229
——: ——; susceptibility to acute and chronic infections, 230
Procaine: preservative; bisulphite, 177
Prosthesis. *See* Denture
Protein: specific dynamic effect; periodontal disease, 207
Psychopathic children: oral signs of degeneration; frequency, 209
Puberty: caries, 214
——: hard palates, 236
Pulp: "biologic" treatment, 208
——: changes; under fillings, 169
——: calcification, 160
——: canals; disinfection—surgical diathermy, 29
——: involved in caries; permeability of teeth, 93, 163
——: neurons, 159
——: paraformaldehyde; metaplastic changes, 189
——: stain; silver bromide, 347
See also Roots, Teeth

QUOTATIONS: dental journals; proprietary control condemned, 475

RADIUM: poisoning; changes in teeth and jaws, 211
RATNER, SARAH: Gies Fellow in Biol. Chem.; Columbia Univ., 474
Research: group caries review; Columbia Univ., 303
——: ——; Michigan Univ., 97, 162
See also Int. Assoc. D. Res., *J. Den. Res.*, Nat. Bur. Standards
Restorations: crown; availability of tube-form of post or dowel, 170
——: mandibular partial denture; non-torque clasp, 457
See also Denture
Retention: appliance; Herbst—for treatment of Angle's Class II, 201. *See also* Denture
Root. *See* Periapical, Pulp, Teeth
ROSEBURY, THEODOR: caries; effects, in mothers and young, of diets deficient in Ca and vitamin D, during pregnancy, lactation, and rearing, 359
——: ——; effects of feeding lactobacilli with caries-producing diets, 231
——: ——; immunization, on caries-producing diets, against lactobacilli, 231
——: ——; influence of coprophagy on mouth flora, 232
——: enamel keratin; iron, 269
——: etiology of fissure caries, 234
——: solubility of enamel; relationship of pH, Ca, and P in acid solvents, 220

SALIVA: acid-neutralizing power, 5
——: action; apatite, 165, 455
——: ——; enamel, 163
——: amylolytic enzyme; relation to caries, 213
——: autolytic enzyme, 205
——: Ca; method, 171, 425
——: ——; review, 161, 387
——: calculus; prevention, 207
——: children; effects of vitamins A and D on pH, 211
——: cholesterol; content, 226, 480
——: composition; caries, 163
——: ——; secretion—correlation, 435

Saliva (*con.*): effects on bacterial growth, 164
——: effects on gastric digestion, 3
——: lecithin; content, 226, 480
——: proteolytic enzymes, 205
——: secretion; correlation with composition, 435
——: ——; rates, 5
SAPER, EVA: bands of Schreger; relation to calcification of enamel, 219
SCHOUR, ISAAC: hypophysectomy; changes in rat molars, 69
——: hypopituitary patient; changes in jaws and teeth, 166
Schreger: bands; relation to calcification of enamel, 219
SCHWARZ, A. M.: treatment of Angle Class II; Herbst retention-appliance, 201
Sclerosis. *See* Caries
Scurvy: acute; tooth germ, 172
——: dental defects; during lactation, 212
Secretion. *See* Gastric conditions, Saliva
SEDWICK, H. J.: caries in children; puberty, 214
——: ——; vitamins A and D, 213
——: high-sugar diet; no effect on teeth, 215
——: maxillary sinus; form, size, and position at various ages, 234
——: ——; relation of teeth to floor, 235
——: puberty; hard palate, 236
——: skulls of pre-Columbian Indians; dental diseases, 235
Sheath of Neumann: optical illusion, 243
SIEGEL, M. T.: brushing teeth; effect on bacterial growth, 164
Silver: bromide; pulp stain, 347
SILVERS, H. F.: alveolar and maxillary bone; regeneration with devitalized heterogeneous bone-powder, 15
ŠKALOUD, FERDINAND: degeneration in psychopathic and neuropathic children; frequency of oral signs, 209
SKILLEN, W. G.: replantation; dog teeth, 177
Skulls: pre-Columbian Indians; dental diseases, 235
——: sinus. *See* Maxillary sinus
SMITH, M. C.: effects of Fl on rate of eruption of incisor; correlation with bone development and body growth, 139, 236
SOUDER, WILMER: dental research; National Bureau of Standards, 184
Spirochetes: Vincent; periodic agranulocytosis, 176, 321
STAFNE, E. C.: cementoma; incidence and phases, 181
STAZ, J.: silver bromide; pulp stain, 347
STEIN, GEORG: new clasp-fixation for partial dentures; method for protection of clasp-teeth, 200
——: treatment of infected pulpless deciduous teeth, 201
STEIN, M. R.: dentition; polyisomerism, 125, 236
STOFSKY, NATHAN: enamel and dentin extracts; caries study, 445
Stomach. *See* Gastric conditions
Streptococci: infected teeth; action of short electric waves, 459
Sugar: blood; periodontal disease, 206
——: excess in diet; no effect on teeth, 215
——: factor in caries, 104, 162
Sulphur dioxide (bisulphite): preservative in solutions of procaine and epinephrine, 177
Surgery: dental (oral); methods, 204
——: diathermy; disinfection; pulp canals and periapical tissues, 29
——: lip cleft; correction, 176
——: postextractive pain; treatment, 205
See also Bone, Cyst, Teeth
Suture: structure; similar to peridental membrane, 160

TAYLOR, W. E.: dental calculus; bacteria, 237
Technic. *See* Method
Teeth (tooth): age and state; relationship of enamel, 28
——: Angle Class II; treatment with Herbst retention appliance, 201
——: brushing; effects on bacterial growth, 164
——: calculus; prevention, 207

Teeth (*con.*): caries; pulpal involvement—permeability, 93, 163. *See also* Caries
——: cementum. *See* Cementum
——: changes; radium poisoning, 211
——: cholesterol; content, 226, 480
——: clasp; protection for partial denture, 200
——: composition, 162, 251
——: ——; conditions of variation, 251
——: cuspid; impacted upper—method, 204
——: deciduous; dangers from premature loss, 225
——: ——; pulpless—focal infection, 201
——: dens in dente, 49
——: dentin. *See* Dentin
——: dento—facial relations. *See* Face
——: diet; aborigines of Tibetan borderland, 210. *See also* Diet
——: dystrophies; during lactation, 212
——: elements; heterotopic formation, 172
——: enamel. *See* Enamel
——: eruption of incisor. *See* "incisor," below
——: extraction; relation to malocclusion, 217. *See also* Surgery
——: fissures; defective—extension for fillings, 203
——: germ; acute scurvy, 172
——: growth; correlated with body-growth, 139, 236, 346
——: high-sugar diet; no effects, 215
——: hypopituitary patient, 166
——: incisor; correlation of eruption with bone development and body growth, 139, 236
——: ——; effects of Fl, 139, 236
——: infected; streptococci—action of short electric waves, 459
——: influence of hypophysectomy, 69
——: "inorganic residue;" apatite formula, 264
——: internal factors; caries, 312
——: irregularities; etiology among Eskimos and Indians, 229
——: lecithin; content, 226, 480
——: malocclusion; affected by extraction, 217
——: maxillary sinus; relation to floor, 235
Teeth (*con.*): molar; first permanent—growth and development, 158
——: ——; growth after eruption, 158, 323
——: ——; influence of hypophysectomy, 69
——: ——; percentage of perfect sets of first permanent, 216
——: non-vital; crown restorations, 170
——: occlusal fillings; extension to include defective fissures, 203
——: orthodontic anomalies; inheritance, 202, 216, 217
——: permeability affected by caries, 93, 163
——: plaque; pH, 218
——: polyisomerism, 125, 236
——: pulp. *See* Pulp
——: radium poisoning, 211
——: replantation; dogs, 177
——: root-end resorption; conditions, 180
——: root resection; method, 204
——: surgery; methods, 204
See also Caries, Dentin, Enamel, Infection, Malocclusion, Pulp, Root
Teleroentgenogram: face; maxillo-facial relations, 224
Temporo-mandibular joint: articulation, 208
Tibet: borderland; diet and dentition of aborigines, 210
Tin: crystalline amalgams; composition, 33
TRAUNER, RICHARD: extension of occlusal fillings; defective fissures, 203
——: methods; dental surgery, 204
——: orthodontic anomalies; inheritance, 202
Treatment: Angle Class II; Herbst retention appliance, 201
——: oral; effects on blood picture in aplastic anemia, 379
——: postextractive pain, 205
——: pulpless deciduous teeth, 201
See also Cyst, Pulp, Surgery, Teeth
Tribes: Tibetan borderland; diet and dentition, 210
TRIMBLE, H. C.: dental plaque; pH, 218
Tumor: mandibular; spontaneous healing, 190

Twins: unilateral distal occlusion; diagnosis, 223

UNITED STATES Public Health Service: dental health survey with A. D. A.; report, 183

VAN DYKE, H. B.: hypophysectomy; changes in rat molars, 69
VAN HUYSEN, GRANT: dentin; x-ray absorption, 168
Vincent spirochetes: periodic agranulocytosis, 176, 321
Vitamin: A and D; effects on caries—children, 213
——: ——; effects on pH of saliva—children, 211
——: D; deficiency—caries study, 359
See also Diet, Teeth

WAINWRIGHT, W. W.: salivary Ca; method, 171, 425
WAINWRIGHT, W. W.: salivary Ca (*con.*); review, 161, 387
WEINER, RICHARD: enamel and dentin extracts; caries study, 445
WEINMANN, JOSEF: saliva; proteolytic enzymes, 205
WILLMAN, WARREN: pulps; calcification, 160
WOLF, E. A.: short electric waves; effects on streptococci from infected teeth, 459
WOLF, HERMANN: carbolated camphor; properties, 205
Women: conditions; relation to caries, 439

X-RAY: absorption; dentin—comparative data, 168
——: cementoma; phases, 181
See also Teleroentgenogram

ZAUS, E. A.: gastric digestion; effects of saliva, 3
Zinc: crystalline amalgams; composition, 33

INTERNATIONAL ASSOCIATION FOR DENTAL RESEARCH

Organized: New York City, Dec. 10, 1920. Of those at the meeting of organization, the following remain active members: Adolph Berger, Theodor Blum, G. W. Clapp, H. S. Dunning, W. J. Gies, H. W. Gillett, R. G. Hutchinson, Jr., T. P. Hyatt, Milo Hellman, F. C. Kemple, A. H. Merritt, B. B. Palmer, P. R. Stillman, L. M. Waugh.

General Meetings have been held on this schedule: (1) New York, Dec. 21, '22. (2) Chicago, Mar. 7, '24. (3) Chicago, Mar. 20, '25. (4) Chicago, Mar. 26, '26. (5) New York, Apr. 19, '27. (6) Washington, Mar. 25–28, '28. (7) Chicago, Mar. 23–24, '29. (8) Toronto, Mar. 24–26, '30. (9) Memphis, Mar. 21–22, '31. (10) Columbus, Mar. 19–20, '32. (11) Chicago, Mar. 18–19, '33; adjourned executive session, New York, May 25, '33. (12) Chicago, Mar. 17–18, '34. *Next general meeting* (13): Chicago, Mar. 16–17, in coördination with the twelfth annual meeting of the American Association of Dental Schools, Mar. 18–20, 1935.

Objects (Const., Art. II): . . . "(a) To promote broadly the advancement of active research in all branches of dental science and in related phases of the sciences that contribute directly to the development of dentistry, and which add to the knowledge of the mouth and teeth and of their relations to the body as a whole; . . . (b) to encourage and facilitate coöperative effort and achievement by, and mutual helpfulness among, investigators in all nations in every division of stomatology; (c) to the end, particularly, that dentistry may render cumulatively more perfect service to humanity." (The Association has been using "dentistry" and "stomatology" as synonyms.)

Membership: total (December 1), 360. *Eligibility (Const., Art. 14, Sec. 1).*—"Any person who has conducted, and published an account of, a meritorious original investigation in dental science, or in any of the sciences contributory to stomatology, shall be eligible to membership in this Association, providing such person conforms to the recognized standards of professional ethics." *Election.*—New members may be elected *only at general meetings of the Association.* Membership in a section is secondary to membership in the Association as a whole. Removal of members from one geographic center to another does not affect their membership in the Association. See the list of members and sections on page 471 of this issue.

Endowment fund (as of April 21, 1934): $1,119.23. There have been no expenditures from this fund.

Divisions may be organized by the members in any nation. There are now divisions in Austria, Canada, China, Czechoslovakia, England, Hungary, South Africa, and the United States—8. *Sections* may be organized by the members in geographic centers within the divisions. There are now sections (26) in Vienna ('29); Halifax ('28), Toronto ('21), Winnipeg ('30); Chengtu ('34); Prague ('32); London ('31); Budapest ('34); Johannesburg ('34); Ann Arbor ('23), Baltimore ('33), Boston ('20), Chicago ('20), Cleveland ('30), Columbus ('32), Louisville ('32), Minnesota ('28), New Haven ('30), New York ('20), Philadelphia ('28), Pittsburgh ('28), Richmond ('33), Rochester ('33), St. Louis ('28), San Francisco ('24), Washington, D. C. ('31). The names of the secretaries are given on p. 2 of this cover.

Sectional meetings in 1934–35 (schedule subject to revision). *Ann Arbor*—May 7. *Baltimore*—Feb. 27. *Boston*—Dec. 10. *Budapest*—Jan. 24 (bi-monthly thereafter). *Chengtu*—Mar. 30, May 11. *Chicago*—Nov. 23, Feb. 15, May 17. *Halifax*—Nov. 23, Jan. 25, Mar. 8. *Johannesburg*—July 5, Sep. 24, Feb. ?, June ?. *London*—Oct. 17, Dec. 5, Jan. 30. *Louisville*—Feb. 15. *Minnesota*—Jan. 21, Feb. 18, Mar. 18, Apr. 15, May ?. *New Haven*—Oct. 18, Jan. 29. *New York*—Jan. 17, May ?. *Philadelphia*—Nov. 23, Jan. 22. *Pittsburgh*—Nov. 13, Jan. 7, Mar. 4, May 6. *Richmond*—Feb. 7. *Rochester*—Sep. 21; Oct. 5, 19; Nov. 2, 16, 30; Dec. 14; Jan. 4, 18; Feb. 1, 15; Mar. 1, 15, 29; Apr. 12, 26; May 10, 24; June 7. *St. Louis*—Nov. 13, Jan. 8, Apr. 9. *San Francisco*—Sep. 12, Oct. 31, Dec. 19, Jan. 30, Feb. 27, Mar. 27, May 1. *Toronto*—July 4, Nov. 30. *Vienna*—Oct. 12. *Washington*—Nov. 12, Apr. 9. *Winnipeg*—Feb. 4, Apr. 8, Oct. 7.

Journal of Dental Research: now the Association's official publication. See register of officers and editors on page 2 of this cover; of editors, on p. ii of the general matter at the end of this number. The names and representatives of supporting societies are listed on page 2 of the cover, and on both title pages in the general matter, of this number.

JOURNAL OF DENTAL RESEARCH

HONORARY EDITORS WHO ARE ABOUT TO RETIRE WITH THE ORIGINAL MANAGEMENT

THEODORE B. BEUST
Louisville
ARTHUR D. BLACK
Evanston
JAMES R. BLAYNEY
Chicago
C. F. BÖDECKER
New York City
B. HOLLY BROADBENT
Cleveland
R. W. BUNTING
Ann Arbor
FRANK COLYER
London
EDGAR D. COOLIDGE
Chicago
KAETHE W. DEWEY
Pittsburgh
F. N. DOUBLEDAY
London
WM. G. DOWNS, JR.
Chicago
C. L. DRAIN
Iowa City
WM. B. DUNNING
New York City
J. J. ENRIGHT
Pittsburgh
GUIDO FISCHER
Hamburg
H. E. FRIESELL
Pittsburgh
HENRY W. GILLETT
New York City
SAMUEL M. GORDON
Chicago
BERNHARD GOTTLIEB
Vienna
WILLIAM K. GREGORY
New York City
EDWARD H. HATTON
Chicago
MILO HELLMAN
New York City
THOMAS J. HILL
Cleveland
PERCY R. HOWE
Boston
THADDEUS P. HYATT
New York City
PHILIP JAY
Ann Arbor
JAN JESENSKY
Prague
V. H. KAZANJIAN
Boston
HENRY KLEIN
New Haven
RUDOLF KRONFELD
Chicago
W. H. G. LOGAN
Chicago
OTTO LOOS
Frankfort
E. V. MCCOLLUM
Baltimore
FREDERICK S. MCKAY
New York City
JOHN A. MARSHALL
San Francisco
ARTHUR H. MERRITT
New York City
C. T. MESSNER
Washington
L. M. S. MINER
Boston
FREDERICK B. NOYES
Chicago
BALINT ORBAN
Vienna
BISSELL B. PALMER
New York City
WESTON A. PRICE
Cleveland
F. M. PUCCI
Montevideo
ISAAC SCHOUR
Chicago
WM. G. SKILLEN
Chicago
WILMER SOUDER
Washington
JOSEF SZABO
Budapest
KURT H. THOMA
Boston
M. L. WARD
Ann Arbor
L. M. WAUGH
New York City
WM. H. WELKER
Chicago
WALTER H. WRIGHT
Pittsburgh

Quotation from a letter to the honorary editors by the retiring management.—"We have endeavored to make the *Journal of Dental Research*, since its establishment in 1919, an exemplar of the best and most meritorious in non-proprietary publication of dental research. The honorary editors have contributed the strength of their approval and support of that effort, and have responded to many calls for assistance. We cordially thank you for the very valuable aid you have given. Your interest and sympathy have fortified the *Journal's* determination to attain its avowed objectives. Your cooperation, accredited in each issue as a public endorsement of our purpose, has facilitated the *Journal's* growth and enhanced its usefulness. The *Journal*, on your recommendation, is about to pass into the complete control of the International Association for Dental Research, which will receive it as a gift from the original management. The Council has voted to place the *Journal* under the direction of a board of editors representative of, and to be selected by, the sections of the Association. Each of you, as a member of the Association, will have opportunity to participate in the recurrent selection of these editors. It is deeply gratifying to us, as we formally sever our past relationship, that the *Journal*, as the official publication of the Association, will continue to have the abiding interest and individual support of its former honorary editors."—*William J. Gies, Executive Officer, Board of Editors.*

INFORMATION FOR PROSPECTIVE SUBSCRIBERS OR CONTRIBUTORS

THE JOURNAL OF DENTAL RESEARCH is dedicated to the advancement of research, and to the dissemination of knowledge, pertaining to the teeth and mouth and to their relations to the body as a whole. It publishes original investigations and reviews in these fields, and in the sciences allied with or applied to them. Although without a "policy," the JOURNAL represents an unwavering purpose to keep widely open the channel to freedom of *responsible* and *respectable* expression of truth and opinion, by individuals or organizations, without qualification by or for any views its editors individually may entertain. Issued bi-monthly, at the *ends* of the months of February, April, June, August, October and December, each volume contains at least 500 pages, for which the subscription price is $5.00.

THE JOURNAL OF DENTAL RESEARCH circulates widely among the most enlightened and progressive dentists and physicians, and among the leading libraries, thus assuring the degree and quality of publicity for its contents that the best dental literature merits. Therefore there can be no important occasion, except in very special instances, for the detailed presentation elsewhere of a paper published in this JOURNAL. Accordingly, to prevent waste of the JOURNAL'S resources in needless duplicate publication, and also to lighten the labors of students of the literature of dentistry, papers in this JOURNAL are not published in, or reprinted from, other dental journals, except for unusual professional reasons. Reprints in any number may be obtained at prices that will be quoted on request.

Address all communications relating to editorial matters to the JOURNAL OF DENTAL RESEARCH, 632 West 168th Street, New York City; business communications, to the JOURNAL OF DENTAL RESEARCH, Mount Royal and Guilford Avenues, Baltimore, Md.

WAVERLY PRESS, INC
BALTIMORE, U. S. A.